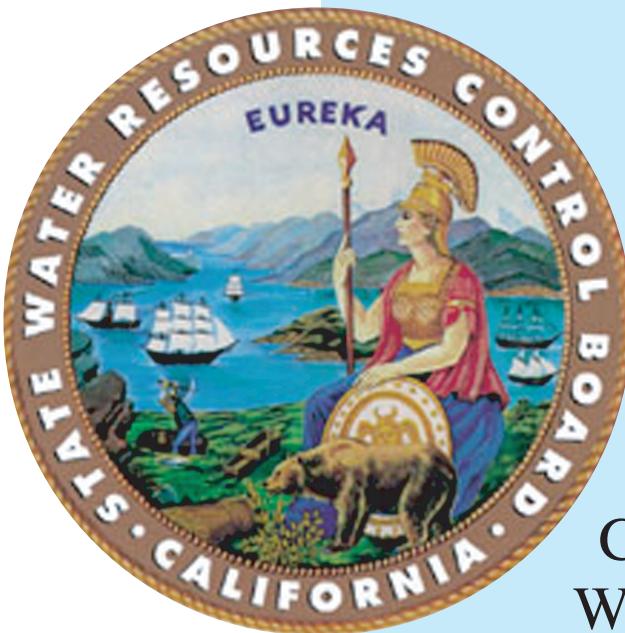


Interpretation of Tritium-³Helium Groundwater Ages and Associated Dissolved Noble Gas Results from Public Water Supply Wells in the Los Angeles Physiographic Basin



Report to the
California State
Water Resources
Control Board



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Executive Summary

The Ambient Groundwater Monitoring and Assessment (GAMA) program, sponsored by the California State Water Resources Control Board (SWRCB), aims to assess the water quality and relative susceptibility of groundwater resources throughout the state of California. In 2001, the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory (LLNL) carried out this vulnerability study in the Coastal Santa Ana Basin and Coastal Los Angeles Basin. The goal of the study is to provide a probabilistic assessment of the relative vulnerability of groundwater used for public water supply to contamination from surface sources. This report briefly describes the tritium-³helium (³H-³He) technique of groundwater age dating, and gives an interpretation of groundwater ages, and associated parameters that are derived from dissolved noble gas analyses. This is a companion report to a USGS study (Shelton et al., 2001), which describes the results of a low-level volatile organic compound (VOC) survey in the same wells, carried out by the USGS. Interpreted together, and in the context of existing water quality and hydrogeologic data, these observable parameters help define the flow field of a groundwater basin, and indicate the degree of vertical connection between near-surface sources (or potential sources) of contamination, and deeper groundwater pumped at high capacity production wells.

A clear pattern in groundwater age is observed in both basins, with younger mean ages closer to the major artificial recharge facilities, and older ages in downgradient wells. The flow field reflected in the groundwater ages is dominated by the artificial recharge facilities and intense groundwater pumping that have taken place on a large scale over several decades. Wells with comparably young mean ages can be classified as vulnerable, since water and associated contaminants of the industrial age reach these wells relatively quickly from surface and near-surface sources. Indeed, these are the same wells with comparably high frequencies of occurrence of low-level VOCs (Shelton et al., 2001). A substantial number of wells (59 public supply wells of the 176 tested), in the distal regions of the flow field, are devoid of tritium, delineating a region where the groundwater produced at these wells recharged the aquifer more than about 50 years ago. This result indicates that vertical transport in the distal region (or ‘pressure area’) of these basins is severely limited by thick clay confining units above the main aquifers. At a small number of the wells with old groundwater ages, VOCs were detected and non-advectional transport of the contaminant is suspected.

It is important to note that the mean ³H-³He ages reported here actually represent a broad age distribution, since most of the Los Angeles Basin and Santa Ana Basin waters analyzed from these wells have measured tritium values that indicate mixing between young water and a significant component of water older than 50 years (‘pre-modern’). With the exception of a small number of wells near the recharge facilities, the wells in these basins produce water that is greater than 50% pre-modern, and any industrial-aged (or ‘post-modern’) signal is diluted by at least that factor. Bulk mean flow rates for each basin can be calculated based on groundwater ages and are in the 1,000 ft/yr range. An examination of the spatial distribution of ages suggests that hydrodynamic dispersion plays a large role in mixing (and dilution) during transport. These data suggest that vertical transport rates are low except in the forebay, and that horizontal transport rates decrease with increasing depth in the basin.

Dissolved noble gas analyses supply additional information about the location and mechanism of recharge, and about very old groundwater, recharged hundreds to thousands of years ago. Specifically, dissolved noble gas analyses can be used to calculate groundwater recharge temperature, ‘excess air’, and radiogenic ⁴Helium (⁴He_{rad}) age (a measure of the presence of groundwater thousands to hundreds of thousands of years old). In general, these parameters follow the pattern observed for groundwater age, i.e., wells with young mean ages and smaller fractions of pre-modern water have higher recharge temperatures and more ‘excess air’, while wells with older mean ages and greater fractions of pre-modern water have higher ⁴He_{rad} concentrations, lower recharge temperatures, and lower ‘excess air’ concentrations. These trends are all related to the recharge and flow patterns established by the engineered recharge facilities and pumping. Episodic artificial recharge provides a mechanism for trapping large amounts of excess air, and results in a higher than natural recharge temperature. Several of the noble gas-derived parameters, including excess air concentration, indicate that ‘native’ groundwater is present in the distal part of the Los Angeles Basin. This is apparently the only large area in the region where there is an archive of native groundwater.

1. Introduction

The California State Water Resources Control Board (SWRCB), in response to concerns expressed by the California Legislature and private citizens, has implemented a program to assess groundwater quality and provide a predictive capability for identifying areas that are vulnerable to contamination. The program was initiated because of concern about recent public supply well closures due to the presence of chemicals, such as methyl tertiary butyl ether (MtBE) from gasoline, and various solvents from industrial sources. As a result of this increased awareness regarding groundwater quality, the Supplemental Report of the 1999 Budget Act required the SWRCB to develop a comprehensive ambient groundwater-monitoring plan. To meet this mandate, the SWRCB created the Ambient Groundwater Monitoring and Assessment (GAMA) Program. The primary objective of the GAMA Program is to assess the water quality and relative susceptibility of groundwater resources throughout the state of California. Under the GAMA program, scientists from Lawrence Livermore National Laboratory (LLNL) collaborate with the SWRCB, the U.S. Geological Survey (USGS), the California Department of Health Services (DHS), and the California Department of Water Resources to implement this groundwater assessment program.

In 2001, the USGS and LLNL carried out this vulnerability study in the Coastal Santa Ana Basin and Coastal Los Angeles Basin. The goal of the study is to provide a probabilistic assessment of the relative vulnerability of groundwater used for the public water supply to contamination from surface sources.. This assessment of relative contamination vulnerability is made based on the results of two types of analyses that are not routinely carried out at public water supply wells: ultra low-level measurement of volatile organic compounds (VOCs), and groundwater age dating (using the tritium-³helium [³H-³He] method). An extensive report that describes the results of the VOC survey was published by the USGS (Shelton et al., 2001). The report contains information regarding the hydrogeologic setting, well selection techniques, and interpretation of VOC occurrences. The present report briefly describes the ³H-³He technique of groundwater age dating, and gives an interpretation of groundwater ages, and associated parameters that are derived from dissolved noble gas analyses. Interpreted together with VOCs, and in the context of existing water quality and hydrogeologic data, these observable parameters help define the flow field of a groundwater basin, and indicate the degree of vertical connection between near-surface sources (or potential sources) of contamination, and deeper groundwater pumped at high capacity production wells.

1.1. Background

1.1.1. Groundwater Age-Dating Technique

Tritium (³H) is a very low abundance (approximately 1 atom per 10^{17} total hydrogen atoms), radioactive isotope of hydrogen with a half-life of 12.34 years. Atmospheric nuclear weapons testing in the 1950s and early 1960s released tritium to the atmosphere at levels several orders of magnitude above the background concentration (which results from cosmic ray interaction with isotopes in the atmosphere). This atmospheric tritium enters groundwater (as HTO with tritium as part of the water molecule) during recharge. The concentration of tritium in groundwater

decreases by radioactive decay, dilution with non-tritiated groundwater, and dispersion. While the presence of tritium is an excellent indicator of water that recharged less than about 50 years ago, age dating groundwater using tritium alone results in large uncertainties due to spatial and temporal variation in the initial tritium concentration at recharge. Measurement of both tritium and its daughter product ³He allows calculation of the initial tritium, and ages can be determined from the following relationship:

$$\text{Groundwater Age} = -17.8 \times \ln(1 + \frac{\text{He}_{\text{trit}}}{\text{He}^3}) \quad (1)$$

The age measures the time since the water sample was last in contact with the atmosphere. The tritiogenic ³He (³He_{trit}) indicated in the equation is the component of ³He that has accumulated in the groundwater from decay of tritium. Methodologies have been developed for correcting for other sources of ³He, such as the earth's atmosphere and potential small contributions from thorium (Th) and uranium (U) decay (Aesbach-Hertig et al., 1999; Ekwurzel et al., 1994), and are described in greater detail in the discussion below. Briefly, if the ⁴Helium (⁴He) concentration measured in the water can be attributed solely to atmospheric sources (from equilibration with air during recharge and "excess air" – see discussion below), it can be assumed that ³He in the water is of atmospheric and tritiogenic origin. Well water samples are always a mixture of water molecules with an age distribution that may span a wide range. The reported groundwater age is the mean age of the mixed sample, and furthermore, is the age only of the portion of the water that contains measurable tritium (see discussion below regarding deconvolution of the mixed, mean age).

Groundwater age dating has been applied in several studies of basin-wide flow and transport (Ekwurzel et al., 1994; Schlosser et al., 1988; Poreda et al., 1988; Szabo et al., 1996; Solomon et al., 1992). The basic premise for using groundwater age to establish vulnerability is that groundwater with a relatively rapid vertical transport rate has a younger age. Since most contaminants are present near the earth's surface, younger groundwater is therefore more vulnerable. Old groundwater is more likely to be isolated from the contaminating activities that are ubiquitous in the urban and suburban environments.

1.2. Results and Discussion

This report describes results for 176 public water supply wells and 36 monitoring wells, sampled by the USGS from August through November of 2000 (Figure 1a). Two types of samples were collected and analyzed for the age-dating part of the vulnerability assessment. A one liter raw groundwater sample, collected during well operation upstream of any treatment, is used to measure the tritium concentration, by the ³He in-growth method (Clark et al., 1976; Surano et al., 1992; Beyerle et al., 2000). The sampling procedure for dissolved noble gases, which involves sealing 10 mL of water in a copper tube without exposing the sample to the atmosphere, is described in Appendix A. The ratio of ³He/⁴He and the concentrations of the dissolved noble gases helium ⁴He, neon (Ne), argon (Ar), krypton (Kr), and xenon (Xe), are measured by noble gas mass spectrometry. The tritium and noble gas analyses are used to calculate the groundwater age, while the radiogenic ⁴He (⁴He_{rad}) concentration, 'excess air' concentration, and the temperature of recharge are determined from the noble gas concentrations. A detailed procedure for each type of analysis, as carried out at LLNL, is given in Appendix A. Data quality control and quality assurance measures along with detection limits, accuracy and

precision requirements, and results of duplicate analyses, are also given in Appendix A. Table 1 lists a subset of relevant analytical results, and results of calculations of groundwater age, ${}^4\text{He}_{\text{rad}}$ concentration, ${}^3\text{He}$ tritium concentration, calculated recharge temperature (RT), excess air concentration, and a measure of the goodness of fit to a model describing the various dissolved gas components (χ^2). Uncertainties shown in Table 1 are the propagated analytical errors only – uncertainty in the reported mean age is discussed below. Table B-1 in Appendix B shows the results for the full analytical suite used to derive the results in Table 1.

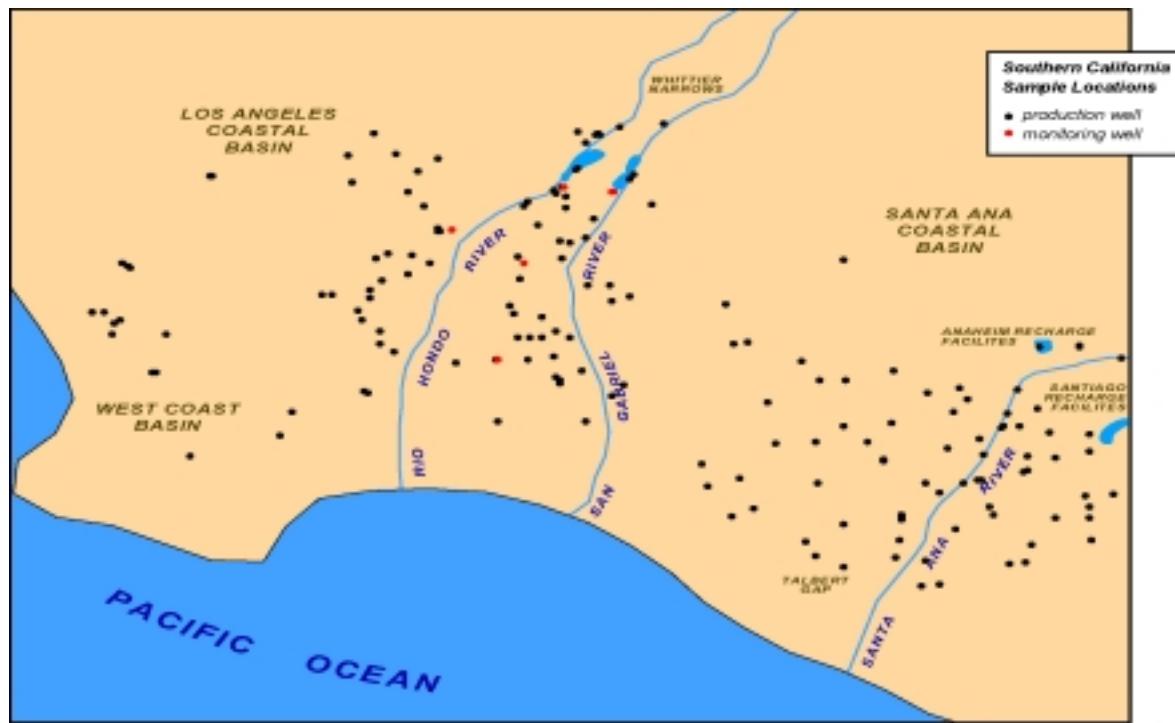


Figure 1a. Well location map showing the major artificial recharge areas and streams, and wells sampled for the CAS study. Monitoring well data is shown in Figure 2 only.

1.2.1. Mean Groundwater Ages

Mean groundwater ages for the same wells sampled by the USGS and described in Shelton et al., 2001, are shown in Figure 1b. In both groundwater basins a clear pattern emerges where younger mean ages are observed closer to the major artificial recharge facilities, while wells with older ages are found downgradient from artificial recharge areas. The flow field reflected in the groundwater ages is dominated by the artificial recharge facilities, and intense groundwater pumping, that have taken place on a large scale over several decades. Wells with comparably young mean ages can be classified as vulnerable, since water and associated contaminants of the industrial age, reach these wells relatively quickly from surface and near-surface sources (see comparison with VOC results below). A substantial number of wells (59 public supply wells), in the distal regions of the flow field, are devoid of tritium, delineating a region where nearly all of the groundwater produced at these wells recharged the aquifer more than about 50 years ago. Evidently, vertical transport is extremely limited in a large portion of these groundwater basins.

Table 1. A subset of analytical and calculated results from tritium and noble gas analyses for Los Angeles County and Orange County wells.

LLNL ID	State well ID	Owner ID	Sample date	$\delta^{18}\text{O}_{\text{smow}}$ (‰)	Tritium (pCi/L)	Age (years)	Recharge temperature (°C)	Excess air concentration (cm ⁻³ -STP/g)	% Pre-modern	⁴ He _{rad} concentration (cm ⁻³ -STP/g)	Apparent ⁴ He _{rad} age (k years)	chi ²
100575	01S/04W-22D07 S	NEWMARK SBVMWD 1	20000621	-7.7	6.4	7	nc	0.001	73	6.61E-09	0.1	434.1
100576	01S/04W-02D07 S	NEWMARK SIERRA HIGH SCHOOL D7	20000622	-7.5	6.7	9	nc	0.002	71	1.07E-08	0.2	279.5
100577	01S/03W-15K03 S	SANTA ANA RIVERVIEW	20000711	-10.1	22.7	27	18.8	0.026	63	<1E-9	<0.1	5.7
100578	01S/03W-15K05 S	SANTA ANA RIVERVIEW	20000713	-9.6	12.5	1	17.4	0.022	54	<1E-9	<0.1	2.5
100579	04S/12W-05H06 S	LAKWOOD 2	20000814	-7.2	0.9	>50	15.2	0.003	100	6.83E-09	0.1	0.2
100580	04S/12W-05H10 S	LAKWOOD 6	20000815	-7.8	9.9	25	15.7	0.008	80	<1E-9	<0.1	7.7
100581	04S/12W-05H07 S	LAKWOOD 3	20000814	-8.2	0.0	>50	nc	0.004	100	3.86E-09	<0.1	2,077.9
100582	04S/12W-05H08 S	LAKWOOD 4	20000815	-8.1	0.4	>50	15.6	0.003	100	1.24E-08	0.2	0.1
100583	03S/12W-09J02 S	DOWNEY 1-02	20000821	-8.9	20.6	31	15.2	0.009	76	<1E-9	<0.1	2.0
100584	03S/12W-09J05 S	DOWNEY 1-05	20000817	ns	ns	nc	17.5	0.005	nc	<1E-9	<0.1	8.0
100585	04S/12W-05H09 S	LAKWOOD 5	20000816	-8.3	0.1	>50	15.3	0.004	100	9.10E-09	0.2	4.8
100586	03S/12W-09J06 S	DOWNEY 1-06	20000822	-7.9	38.8	17	nc	0.012	-38	<1E-9	<0.1	10.3
100587	03S/12W-09J03 S	DOWNEY 1-03	20000822	-9.3	88.0	28	nc	0.011	-37	<1E-9	<0.1	11.9
100588	03S/12W-09J04 S	DOWNEY 1-04	20000822	-8.4	46.1	26	17.9	0.008	12	<1E-9	<0.1	4.2
100589	03S/12W-06B08 S	SOUTH GATE 05	20000824	-7.5	0.1	>50	16.2	0.005	100	<1E-9	<0.1	7.6
100590	03S/12W-09J01 S	DOWNEY 1-01	20000817	-8.5	-0.1	>50	nc	0.003	100	<1E-9	<0.1	125.6
100591	03S/13W-12J01 S	LYNWOOD 05	20000831	-8.3	32.2	27	nc	0.008	47	1.28E-09	<0.1	nc
100592	03S/12W-06B06 S	SOUTH GATE 03	20000824	-8.8	73.9	30	15.8	0.012	2	<1E-9	<0.1	1.8
100593	03S/12W-06D02 S	SOUTH GATE 14	20000829	-8.4	34.4	25	nc	0.009	32	<1E-9	<0.1	nc
100594	03S/12W-33A07 S	LAKWOOD 2A	20000828	-9.5	25.7	29	nc	0.005	62	<1E-9	<0.1	nc
100595	03S/12W-16H01 S	PARK 40D	20000829	-8.5	43.8	27	23.7	0.009	24	<1E-9	<0.1	7.8
100596	03S/12W-06B05 S	SOUTH GATE 02	20000823	-8.5	52.6	24	20.1	0.011	-12	<1E-9	<0.1	4.1
100597	03S/12W-06B07 S	SOUTH GATE 04	20000823	-8.6	40.5	25	17.3	0.011	17	<1E-9	<0.1	2.3
100598	02S/12W-28J06 S	DOWNEY 07	20000830	-8.0	21.1	10	19.8	0.009	9	<1E-9	<0.1	2.0
100599	03S/12W-11E01 S	DOWNEY 24	20000830	-8.5	42.8	24	16.7	0.008	2	<1E-9	<0.1	0.3
100600	02S/12W-26D09 S	RIO HONDO 1	20000907	-8.5	0.2	>50	16.9	0.008	100	2.67E-08	0.5	2.0
100601	02S/12W-26D12 S	RIO HONDO 4	20000906	-8.2	23.9	10	21.3	0.011	-2	<1E-9	<0.1	1.8
100602	02S/12W-25G01 S	PICO RIVERA W12	20000831	-7.6	26.0	25	nc	-0.003	46	4.34E-08	0.9	nc
100603	02S/12W-25G03 S	PICO 2-1	20000911	-8.4	26.8	21	19.7	0.006	28	3.94E-09	<0.1	0.4
100604	02S/12W-26D13 S	RIO HONDO 5	20000906	-7.5	20.0	8	17.4	0.009	14	1.02E-09	<0.1	8.2
100605	01S/02W-07Q01 S	SANTA ANA CONE CAMP 1	20000807	-9.5	4.9	47	18.8	0.011	99	2.13E-08	0.4	4.8
100606	02S/12W-26D10 S	RIO HONDO 2	20000907	-9.0	59.0	34	15.0	0.010	46	<1E-9	<0.1	8.0
100607	02S/12W-25G04 S	PICO 2-2	20000912	-8.5	40.9	21	14.5	0.008	-10	2.29E-09	<0.1	0.7
100608	02S/12W-25G07 S	PICO 2-5	20000914	-7.3	25.5	3	16.7	0.007	0	<1E-9	<0.1	2.4

Table 1. A subset of analytical and calculated results from tritium and noble gas analyses for Los Angeles County and Orange County wells. (Cont.)

LLNL ID	State well ID	Owner ID	Sample date	$\delta^{18}\text{O}_{\text{smow}}$ (‰)	Tritium (pCi/L)	Age (years)	Recharge temperature (°C)	Excess air concentration (cm ³ -STP/g)	% Pre-modern	${}^4\text{He}_{\text{rad}}$ concentration (cm ³ -STP/g)	Apparent ${}^4\text{He}_{\text{rad}}$ age (k years)	chi ²
100609	02S/12W-25G06 S	PICO 2-4	20000913	-7.8	24.7	9	17.3	0.007	-6	<1E-9	<0.1	1.4
100610	02S/12W-25G08 S	PICO 2-6	20000912	-8.4	30.2	7	nc	0.064	-29	7.33E-08	1.5	40.0
100611	02S/12W-25G05 S	PICO 2-3	20000913	-8.7	44.7	29	14.3	0.019	36	4.06E-08	0.8	0.5
100612	02S/12W-26D14 S	RIO HONDO 6	20000906	-7.7	25.8	2	16.5	0.010	3	<1E-9	<0.1	4.8
100613	01S/03W-14E01 S	RIVERVIEW PRODUCTION	20000809	-9.8	15.5	25	nc	0.037	68	<1E-9	<0.1	19.3
100614	02S/12W-26D11 S	RIO HONDO 3	20000906	-8.7	26.2	25	18.3	0.012	47	8.27E-09	0.2	0.7
100615	03S/13W-21C06 S	PARK 13B	20001012	-7.9	13.6	33	nc	0.009	87	2.55E-09	<0.1	nc
100616	03S/13W-21B01 S	PARK 13C	20001012	-7.7	13.5	41	nc	0.147	94	1.68E-07	3.4	37.4
100617	03S/12W-24K01 S	PARK 06E	20001012	-8.0	40.8	25	nc	0.014	16	<1E-9	<0.1	nc
100618	02S/12W-11R04 S	MONTEBELLO 11A	20001010	-8.4	27.4	19	17.5	0.008	12	<1E-9	<0.1	2.6
100619	04S/12W-11B03 S	LAKWOOD 16	20001011	-8.4	0.0	>50	nc	0.002	100	2.64E-09	<0.1	nc
100620	02S/11W-11G01 S	MONTEBELLO 14	20001010	-8.6	24.7	35	17.5	0.005	80	4.29E-09	<0.1	9.0
100621	04S/12W-10H03 S	LAKWOOD 8	20001011	-8.1	0.2	>50	nc	0.003	100	5.40E-09	0.1	nc
100622	03S/11W-19E02 S	PARK 29K	20001012	-8.6	33.6	31	nc	0.010	62	5.48E-09	0.1	nc
100623	04S/12W-07M01 S	LAKWOOD 6	20001011	-8.2	0.5	>50	nc	0.002	100	2.23E-09	<0.1	nc
100624	02S/12W-12M02 S	MONTEBELLO 07	20001010	-7.9	21.2	10	18.2	0.004	9	<1E-9	<0.1	3.5
100625	04S/12W-04J03 S	LAKWOOD 12	20001010	-8.2	0.6	>50	nc	0.004	100	1.52E-09	<0.1	48.2
100626	04S/12W-13B04 S	LB COMMISSION 19	20000928	-8.1	0.2	>50	nc	0.031	100	2.21E-08	0.4	nc
100627	04S/13W-29E06 S	DOMINGUEZ 75A	20001012	-7.6	0.1	>50	15.8	0.001	100	6.74E-08	1.3	3.1
100628	03S/11W-34L01 S	BP CABALLERO	20001011	-8.3	0.5	>50	14.2	0.002	100	5.55E-09	0.1	3.8
100629	04S/12W-21M07 S	LB CITIZENS WELL 7a	20000928	-8.7	0.2	>50	17.0	0.001	100	5.84E-08	1.2	3.4
100630	03S/13W-35F15 S	DOMINGUEZ 90	20001010	-7.3	0.0	>50	13.0	0.003	100	1.06E-08	0.2	7.3
100631	04S/12W-23K03 S	LB ANNEX 201	20000928	-8.4	0.2	>50	17.0	0.001	100	2.02E-08	0.4	2.2
100632	04S/13W-20C01 S	DOMINGUEZ 79	20001012	-7.2	0.0	>50	nc	0.002	100	2.04E-08	0.4	nc
100633	03S/11W-34H03 S	BP KNOTT AVENUE	20001011	-8.2	0.1	>50	nc	0.002	100	4.58E-09	<0.1	nc
100634	03S/12W-06D04 S	SOUTH GATE 19	20001011	-8.2	31.7	25	16.0	0.009	36	<1E-9	<0.1	2.5
100635	03S/12W-06D01 S	SOUTH GATE 13	20001011	-8.2	36.7	26	16.2	0.010	33	<1E-9	<0.1	2.0
100636	04S/11W-01K01 S	BP BOISSERANC	20001011	-8.3	0.2	>50	16.4	0.003	100	1.73E-09	<0.1	0.5
100637	04S/12W-06K01 S	N. LONG BEACH 04	20000928	-9.0	-0.1	>50	nc	0.003	100	1.09E-07	2.2	91.5
100638	04S/13W-15A14 S	DOMINGUEZ 98	20001010	-7.6	0.5	>50	18.7	0.002	100	5.05E-08	1.0	3.8
100639	04S/13W-15A11 S	DOMINGUEZ 15	20001010	-7.7	0.2	>50	nc	-0.001	100	2.77E-09	<0.1	nc
100640	05S/10W-01E03 S	SANTA ANA 36	20000811	-8.5	11.2	33	16.7	0.009	89	<1E-9	<0.1	0.0
100641	05S/11W-01H02 S	GARDEN GROVE 20	20000810	-8.4	2.2	41	15.7	0.006	99	1.81E-09	<0.1	2.0
100642	04S/10W-25F01 S	ANAHEIM 33	20000918	-7.5	18.7	14	20.7	0.016	25	<1E-9	<0.1	0.1
100643	05S/11W-10J04 S	WESTMINSTER 99	20000808	-8.6	0.8	>50	14.5	0.003	100	3.27E-09	<0.1	3.1

Table 1. A subset of analytical and calculated results from tritium and noble gas analyses for Los Angeles County and Orange County wells. (Cont.)

LLNL ID	State well ID	Owner ID	Sample date	$\delta^{18}\text{O}_{\text{smow}}$ (‰)	Tritium (pCi/L)	Age (years)	Recharge temperature (°C)	Excess air concentration (cm ³ -STP/g)	% Pre-modern	${}^4\text{He}_{\text{rad}}$ concentration (cm ³ -STP/g)	Apparent ${}^4\text{He}_{\text{rad}}$ age (k years)	chi ²
100644	04S/10W-33F02 S	GARDEN GROVE 23	20000810	-8.5	30.9	31	17.2	0.010	65	2.64E-09	<0.1	2.9
100645	04S/09W-03H02 S	EMA-AH2	20000920	-7.9	17.1	13	23.6	0.021	30	<1E-9	<0.1	7.5
100646	04S/10W-15B05 S	ANAHEIM 34	20000919	-7.6	18.7	15	17.9	0.008	27	<1E-9	<0.1	1.5
100647	04S/10W-23B02 S	ANAHEIM 19	20000918	-7.9	26.4	27	16.7	0.010	56	<1E-9	<0.1	3.4
100648	05S/10W-18G01 S	WESTMINSTER 04	20000809	-8.3	0.0	>50	17.1	0.006	100	<1E-9	<0.1	3.0
100649	04S/10W-33A04 S	ANAHEIM 36	20000919	-8.2	25.6	23	18.0	0.010	41	<1E-9	<0.1	0.6
100650	05S/10W-03F01 S	GARDEN GROVE 26	20000809	-8.6	14.7	33	16.4	0.008	85	<1E-9	<0.1	2.1
100651	04S/09W-28R02 S	EOCW-E	20000825	-6.9	14.0	40	22.1	0.028	93	1.89E-08	0.4	7.4
100652	04S/09W-19D05 S	TMIX-O	20000823	-7.2	23.2	2	19.2	0.004	13	<1E-9	<0.1	1.6
100653	05S/10W-30K05 S	NB-DOLS	20000821	-7.9	82.6	10	nc	0.010	-255	4.02E-09	<0.1	nc
100654	04S/11W-26J02 S	SCWC-SORG	20000824	-8.3	4.1	31	16.9	0.007	95	<1E-9	<0.1	4.3
100655	05S/10W-01E02 S	SANTA ANA 18	20000824	-7.7	18.6	40	nc	0.054	91	3.64E-08	0.7	12.0
100656	05S/11W-03C01 S	WESTMINSTER SC4	20000808	-8.3	2.5	35	15.3	0.007	98	<1E-9	<0.1	2.1
100657	04S/10W-26N01 S	ORANGE 03	20000822	-7.4	18.2	10	nc	0.009	22	<1E-9	<0.1	nc
100658	04S/10W-33F04 S	GARDEN GROVE 28	20000822	-7.6	21.1	25	nc	0.030	58	2.05E-08	0.4	nc
100659	05S/11W-24F03 S	WESTMINSTER 03	20000807	-8.4	7.3	32	14.8	0.008	92	<1E-9	<0.1	4.8
100660	04S/10W-07E01 S	ANAHEIM 12	20001010	-7.9	20.9	32	15.0	0.010	78	<1E-9	<0.1	0.6
100661	03S/09W-32L01 S	ANAHEIM 43	20001011	-7.8	19.3	13	18.8	0.007	21	<1E-9	<0.1	1.7
100662	04S/11W-14K01 S	ANAHEIM 39	20001010	-8.4	17.8	31	18.4	0.007	79	<1E-9	<0.1	3.7
100663	05S/10W-14L01 S	SANTA ANA 37	20001012	-8.4	0.1	>50	17.8	0.002	100	3.41E-09	<0.1	1.6
100664	04S/10W-20M01 S	ANAHEIM 40	20001010	-9.3	58.0	28	16.0	0.008	10	<1E-9	<0.1	0.1
100665	02S/12W-12A05 S	PICO RIVERA W2	20001011	-8.1	25.3	13	18.2	0.004	-2	<1E-9	<0.1	2.4
100666	02S/12W-23B08 S	PICO RIVERA W4	20001011	-8.1	23.5	31	22.0	0.026	72	4.31E-08	0.9	0.5
100667	05S/10W-16B04 S	SANTA ANA 30	20001012	-8.3	0.9	>50	15.9	0.005	100	<1E-9	<0.1	5.8
100668	02S/11W-19M01 S	LA HABRA 9	20001011	-8.0	27.1	41	nc	0.013	88	1.25E-07	2.5	nc
100669	04S/10W-11Q02 S	ANAHEIM 29	20001011	-7.7	17.3	5	18.4	0.010	29	<1E-9	<0.1	1.9
100670	02S/12W-36M06 S	PICO RIVERA W8	20001011	-8.4	39.1	29	18.1	0.012	43	<1E-9	<0.1	0.4
100671	05S/10W-16B03 S	SANTA ANA 20	20001012	-8.3	-0.2	>50	17.1	0.006	100	<1E-9	<0.1	1.8
100672	05S/09W-19H01 S	SANTA ANA 26	20001012	-8.4	0.1	>50	15.8	0.002	100	1.86E-08	0.4	0.5
100673	04S/10W-14H03 S	ANAHEIM 46	20001011	-8.1	25.2	29	22.5	0.016	65	<1E-9	<0.1	0.1
100674	02S/11W-19F01 S	LA HABRA 8	20001011	-8.2	31.7	17	17.7	0.007	-12	2.32E-09	<0.1	1.2
100675	05S/10W-34H10 S	MESA 01B	20001011	-8.3	0.2	>50	16.2	0.002	100	1.04E-08	0.2	0.9
100676	05S/10W-27C02 S	IRVINE RANCH WATER DISTRICT 16	20001012	-8.6	25.3	15	18.0	0.003	4	7.64E-09	0.2	1.6
100677	04S/10W-08E05 S	ANAHEIM 47	20001010	-8.6	23.3	30	nc	0.006	70	2.66E-09	<0.1	400.7

Table 1. A subset of analytical and calculated results from tritium and noble gas analyses for Los Angeles County and Orange County wells. (Cont.)

LLNL ID	State well ID	Owner ID	Sample date	$\delta^{18}\text{O}_{\text{smow}}$ (‰)	Tritium (pCi/L)	Age (years)	Recharge temperature (°C)	Excess air concentration (cm ³ -STP/g)	% Pre-modern	${}^4\text{He}_{\text{rad}}$ concentration (cm ³ -STP/g)	Apparent ${}^4\text{He}_{\text{rad}}$ age (k years)	chi ²
100678	04S/10W-09B02 S	ANAHEIM 14	20001010	-8.5	42.1	22	nc	0.012	-11	<1E-9	<0.1	304.1
100679	03S/12W-27C02 S	BSMWC 759	20001011	-9.0	44.2	33	14.7	0.008	55	<1E-9	<0.1	0.8
100680	03S/12W-27R01 S	BSMWC 955	20001011	-8.4	13.2	32	14.6	0.004	86	<1E-9	<0.1	1.1
100681	02S/11W-30R03 S	SANTE FE 1	20001012	-8.4	19.7	30	nc	0.006	73	2.00E-08	0.4	nc
100682	03S/11W-22D01 S	LA MIRADA	20001010	-7.8	-0.2	>50	nc	0.003	100	9.84E-08	2.0	168.7
100683	03S/13W-11C01 S	LYNWOOD 06	20001011	-8.2	43.6	29	16.6	0.008	35	<1E-9	<0.1	3.8
100684	03S/13W-12E04 S	LYNWOOD 08	20001011	-8.3	46.0	31	15.2	0.010	43	<1E-9	<0.1	0.9
100685	03S/14W-34C02 S	TORRANCE 6	20001012	-7.2	9.7	34	nc	0.001	92	2.33E-08	0.5	179.1
100686	03S/12W-02H04 S	DOWNEY 12	20001012	8.0	26.7	14	19.0	0.007	-5	<1E-9	<0.1	3.3
100687	03S/10W-07J02 S	IDAHO ST.	20001010	-6.5	0.2	>50	nc	0.004	100	1.84E-07	3.7	nc
100688	03S/12W-33B01 S	BSMWC 615	20001011	-8.5	21.1	30	16.1	0.005	71	<1E-9	<0.1	1.5
100689	02S/12W-34P01 S	DOWNEY 14	20001012	-8.2	31.1	19	18.7	0.011	1	<1E-9	<0.1	1.9
100690	03S/12W-02L01 S	DOWNEY 15	20001012	-8.5	41.8	23	17.0	0.008	2	<1E-9	<0.1	0.8
100691	05S/11W-15D03 S	HUNTINGTON BEACH 01	20001010	-8.3	0.4	>50	17.0	0.005	100	<1E-9	<0.1	5.4
100692	05S/11W-04L01 S	WESTMINSTER 125	20001010	-8.6	0.2	>50	13.1	0.001	100	4.97E-09	<0.1	8.1
100693	01S/15W-31E01 S	SANTA MONICA 1	20001023	-8.0	14.0	24	15.3	0.001	70	4.78E-08	1.0	1.5
100694	02S/15W-04C02 S	SANTA MONICA 3	20001023	-7.2	10.9	12	21.2	0.007	55	<1E-9	<0.1	3.6
100695	02S/12W-18M01 S	MAYWOOD 52 ST	20001025	-8.0	19.7	38	15.6	0.006	89	1.90E-08	0.4	0.7
100696	03S/14W-32A02 S	HERMOSA 8-02	20001026	-8.2	65.3	31	17.2	0.001	23	9.13E-09	0.2	0.1
100697	02S/13W-22P02 S	HUNTINGTON PARK 15	20001024	-7.3	0.4	>50	15.4	0.004	100	<1E-9	<0.1	0.6
100698	02S/13W-14H05 S	VERNON 19	20001025	-7.4	0.3	>50	16.4	0.003	100	8.94E-09	0.2	0.4
100699	02S/14W-23H14 S	MANHATTAN 05	20001024	-7.3	-0.4	>50	17.6	0.003	100	<1E-9	<0.1	0.3
100700	04S/11W-33L01 S	GARDEN GROVE 16	20001023	-8.4	-0.3	>50	16.0	0.003	100	<1E-9	<0.1	0.2
100701	02S/15W-04A01 S	SANTA MONICA 4	20001023	-7.1	14.3	15	18.5	0.003	45	3.94E-09	<0.1	0.0
100702	02S/13W-25Q01 S	HUNTINGTON PARK 12	20001024	-8.1	32.6	31	16.9	0.006	60	4.24E-09	<0.1	5.1
100703	02S/14W-23H02 S	MANHATTAN 03A	20001024	-7.3	1.0	>50	17.4	0.006	100	<1E-9	<0.1	0.4
100704	02S/13W-15E02 S	VERNON 18	20001025	-7.2	0.2	>50	16.5	0.003	100	2.92E-09	<0.1	5.6
100705	02S/13W-11E04 S	VERNON 14	20001025	-7.1	0.3	>50	14.8	0.006	100	5.94E-09	0.1	0.3
100706	03S/14W-29J01 S	HERMOSA 22-01	20001026	-8.3	33.0	32	nc	0.005	66	<1E-9	<0.1	965.1
100707	03S/14W-29H01 S	HERMOSA 30-01	20001026	-7.3	2.7	34	nc	0.002	98	1.23E-08	0.2	358.7
100708	04S/09W-32B04 S	ORANGE 25	20001026	-8.2	3.4	37	19.4	0.010	98	6.46E-09	0.1	0.6
100709	03S/14W-09M01 S	HAWTHORNE 9M1 (WELL 13)	20001025	-6.8	-0.6	>50	nc	-0.010	100	<1E-9	<0.1	nc
100710	04S/14W-10D04 S	DOMINGUEZ 33	20001024	-8.3	65.2	35	19.4	0.001	50	2.17E-08	0.4	3.5
100711	05S/09W-30G02 S	IRVINE 3 (DYER ROAD)	20000927	-8.4	0.2	>50	nc	0.001	100	3.38E-08	0.7	nc
100712	05S/11W-24R04 S	HUNTINGTON BEACH 09	20000926	-8.6	0.2	>50	nc	0.001	100	1.94E-09	<0.1	nc

Table 1. A subset of analytical and calculated results from tritium and noble gas analyses for Los Angeles County and Orange County wells. (Cont.)

LLNL ID	State well ID	Owner ID	Sample date	$\delta^{18}\text{O}_{\text{smow}}$ (‰)	Tritium (pCi/L)	Age (years)	Recharge temperature (°C)	Excess air concentration (cm ³ -STP/g)	% Pre-modern	${}^4\text{He}_{\text{rad}}$ concentration (cm ³ -STP/g)	Apparent ${}^4\text{He}_{\text{rad}}$ age (k years)	chi ²
100713	04S/10W-27K01 S	GARDEN GROVE 19	20000926	-8.9	43.4	26	nc	0.009	15	1.29E-09	<0.1	nc
100714	05S/09W-30E01 S	IRVINE 5	20000927	-8.3	-0.1	>50	nc	-0.010	100	<1E-9	<0.1	nc
100715	04S/10W-30E02 S	GARDEN GROVE 27	20000926	-8.6	27.1	31	17.0	0.006	67	3.86E-09	<0.1	5.0
100716	01S/04W-22D05 S	NEWMARK SBVMWD 4	20000620	-8.4	12.8	59	nc	0.048	99	3.58E-07	7.2	31.5
100717	01S/04W-22J04 S	SANTA ANA COMMERCE	20000726	-8.1	-0.2	>50	nc	0.001	100	1.52E-09	<0.1	88.5
100718	01S/03W-15K04 S	SANTA ANA RIVERVIEW	20000712	-10.1	15.7	8	nc	0.023	33	<1E-9	<0.1	31.5
100719	04S/09W-28A01 S	ORANGE 24	20001026	-7.1	13.6	35	nc	0.036	89	3.13E-08	0.6	24.5
100720	03S/14W-09N04 S	HAWTHORNE 9N4 (WELL 4)	20001025	-7.1	-1.2	>50	nc	0.358	100	<1E-9	<0.1	83.2
100721	03S/12W-21L01 S	PEERLESS 10	20001024	-7.6	1.0	>50	15.2	0.002	100	<1E-9	<0.1	6.1
100722	06S/08W-12Q01 S	LOS ALISOS 2	20001026	-5.5	0.1	>50	17.6	0.005	100	9.75E-09	0.2	8.5
100723	03S/14W-09N05 S	HAWTHORNE 9N5 (WELL 12)	20001025	-7.1	0.6	>50	nc	-0.009	100	5.10E-08	1.0	826.1
100724	05S/10W-34F03 S	MESA 09	20001026	-8.4	9.4	17	17.9	0.001	67	1.36E-08	0.3	5.8
100725	05S/09W-09K01 S	TUSTIN COLUMBUS	20001023	-8.0	3.1	93	nc	0.059	100	2.04E-07	4.1	13.4
100726	03S/12W-35F03 S	PEERLESS 17	20001024	-8.2	9.6	28	14.5	0.004	85	<1E-9	<0.1	2.9
100727	03S/09W-33K05 S	YORBA LINDA 12	20001026	-7.8	19.1	9	17.2	0.003	18	2.95E-09	<0.1	0.4
100728	05S/09W-16C01 S	TUSTIN MAIN STREET 3	20001023	-7.4	19.5	48	18.2	0.016	96	9.89E-08	2.0	4.4
100729	05S/09W-10C02 S	TUSTIN 17TH STREET 2	20001023	-7.1	21.7	84	19.8	0.011	100	1.13E-06	22.7	3.7
100730	03S/12W-13Q01 S	NORWALK TADDY 05	20001025	-7.4	32.3	14	21.1	0.013	-28	<1E-9	<0.1	6.2
100731	06S/08W-01N01 S	LOS ALISOS 7	20001026	-5.7	-1.7	>50	16.9	0.007	100	2.58E-08	0.5	4.5
100732	02S/13W-24F01 S	MAYWOOD 03	20001024	-8.5	33.5	34	16.4	0.012	71	<1E-9	<0.1	2.0
100733	03S/13W-35Q06 S	DOMINGUEZ 31A	20001024	-8.2	1.5	>50	15.9	0.001	100	5.65E-08	1.1	4.9
100734	05S/09W-21B01 S	TUSTIN WALNUT 77	20001023	-7.7	2.0	89	18.2	0.003	100	1.04E-07	2.1	6.7
100735	03S/09W-33K06 S	YORBA LINDA 10	20001026	-8.0	18.9	19	17.7	0.004	41	<1E-9	<0.1	3.8
100736	03S/12W-28C01 S	PEERLESS 03	20001024	-7.6	0.8	>50	14.9	0.001	100	<1E-9	<0.1	0.4
100737	04S/14W-10D03 S	DOMINGUEZ 32	20001024	-8.7	80.1	38	17.6	0.001	54	1.26E-08	0.3	0.8
100738	03S/12W-09G01 S	DOWNEY 29	20001108	-8.4	50.5	27	18.8	0.010	16	3.39E-09	<0.1	4.8
100739	04S/12W-10J02 S	LAKewood 14	20001106	-8.2	0.2	>50	17.7	0.003	100	6.37E-09	0.1	1.9
100740	04S/12W-10G01 S	LAKewood 4	20001106	-7.9	0.0	>50	16.7	0.003	100	1.09E-08	0.2	1.0
100741	04S/14W-35E07 S	LOMITA 5	20001107	-6.2	1.0	>50	nc	0.001	100	3.20E-08	0.6	92,216.0
100742	03S/14W-09P01 S	HAWTHORNE P1 (WELL 8)	20001106	-7.1	0.4	>50	18.9	0.000	100	2.13E-07	4.3	1.6
100743	03S/14W-11R04 S	MANHATTAN 11A	20001107	-8.1	70.5	32	nc	0.001	22	4.73E-08	0.9	28.3
100744	03S/14W-29C03 S	MANHATTAN 15	20001107	-8.1	23.0	30	nc	0.001	70	2.81E-08	0.6	110.7
100745	03S/13W-11E01 S	LYNWOOD 11	20001108	-8.3	44.0	32	16.3	0.012	51	9.83E-09	0.2	0.4
100746	03S/13W-13D01 S	LYNWOOD 09	20001108	-8.4	33.3	31	16.6	0.007	62	2.01E-09	<0.1	3.7
100747	03S/12W-03J01 S	DOWNEY 16	20001108	-8.3	37.2	21	18.7	0.007	-4	<1E-9	<0.1	6.7

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100748	02S/12W-27A05 S	DOWNEY 01	20001108	-8.3	30.9	21	17.7	0.005	15	<1E-9	<0.1	7.6
100749	03S/13W-26M01 S	COMPTON 14	20001108	-7.4	-0.7	>50	15.0	0.003	100	1.01E-08	0.2	0.1
100750	02S/12W-28Q01 S	DOWNEY 08	20001106	-7.3	20.5	10	18.8	0.009	12	<1E-9	<0.1	1.5
100751	02S/12W-35D02 S	DOWNEY 05	20001106	-8.0	17.1	20	17.4	0.015	48	<1E-9	<0.1	0.2
100752	02S/12W-27H01 S	DOWNEY 02	20001106	ns	ns	nc	nc	0.010	nc	<1E-9	<0.1	nc
100753	02S/12W-12E08 S	MONTEBELLO 12	20001107	-8.4	25.3	17	17.9	0.003	10	<1E-9	<0.1	0.5
100754	02S/12W-12E07 S	MONTEBELLO 8A	20001107	-8.2	22.6	20	nc	0.007	32	<1E-9	<0.1	599.5
100755	02S/12W-23B04 S	PICO RIVERA W3	20001107	-7.7	24.4	11	21.2	0.012	-4	<1E-9	<0.1	1.9
100756	02S/12W-26D07 S	PICO RIVERA W5	20001107	-7.5	23.2	7	19.3	0.009	1	<1E-9	<0.1	1.4
100757	02S/11W-05N04 S	WHITTIER 14	20001107	-8.1	25.3	15	20.0	0.005	4	<1E-9	<0.1	4.3
100758	02S/12W-26E03 S	PICO RIVERA W6	20001107	ns	ns	nc	19.9	0.008	nc	<1E-9	<0.1	1.9
100759	03S/13W-15R01 S	COMPTON 02	20001107	-7.4	1.8	>50	14.0	0.003	100	<1E-9	<0.1	0.5
100760	03S/13W-22H02 S	COMPTON 01	20001107	-7.1	0.3	>50	14.5	0.003	100	<1E-9	<0.1	0.3
100761	03S/14W-27G01 S	COMPTON 15	20001107	-7.4	0.8	>50	17.5	0.003	100	2.81E-09	<0.1	7.4
100762	04S/12W-03H01 S	LAKewood 17	20001106	-8.7	18.9	33	16.1	0.005	82	<1E-9	<0.1	5.4
100763	03S/13W-22Q04 S	COMPTON 09	20001107	-7.4	0.2	>50	14.2	0.005	100	1.57E-09	<0.1	5.2
100764	04S/12W-05J01 S	LAKewood 22	20001106	-8.2	-0.1	>50	15.1	0.003	100	1.16E-08	0.2	4.8
100765	02S/13W-25D04 S	HUNTINGTON PARK 16	20001108	-7.4	1.7	>50	14.2	0.003	100	3.91E-09	<0.1	1.3
100766	03S/12W-34F01 S	LAKewood 18	20001106	-8.8	26.2	32	nc	0.010	71	<1E-9	<0.1	326.4
100767	03S/13W-14F15 S	COMPTON 18	20001107	-8.2	18.0	29	16.0	0.005	73	<1E-9	<0.1	3.6
100768	04S/10W-36C02 S	ORANGE 20	20001106	-8.7	19.8	35	16.1	0.011	84	<1E-9	<0.1	0.9
100769	04S/09W-17N01 S	ORANGE 21	20001106	-8.5	30.5	40	17.0	0.023	85	7.68E-09	0.2	3.3
100770	04S/09W-20P01 S	ORANGE 22	20001106	-7.8	11.5	36	nc	0.045	92	<1E-9	<0.1	175.2
100771	04S/10W-24J02 S	ORANGE 09	20001106	-7.8	23.5	30	18.8	0.020	70	1.94E-09	<0.1	1.5
100772	05S/10W-13B09 S	SANTA ANA 29	20001107	-8.2	3.7	24	16.0	0.007	92	<1E-9	<0.1	1.7
100773	04S/10W-24J01 S	ORANGE 08	20001106	-8.0	26.0	30	16.0	0.014	68	1.70E-09	<0.1	0.1
100774	05S/10W-12L03 S	SANTA ANA 16	20001107	-7.2	11.5	33	nc	0.074	88	<1E-9	<0.1	29.1
100775	04S/09W-31R01 S	SANTA ANA 28	20001108	-8.0	8.8	25	18.3	0.012	83	<1E-9	<0.1	6.3
100776	04S/09W-19K01 S	ORANGE 19	20001108	-7.8	17.2	26	18.4	0.015	66	<1E-9	<0.1	0.7
100777	04S/09W-31B02 S	ORANGE 18	20001108	-8.4	14.2	34	17.5	0.014	87	<1E-9	<0.1	0.3
100778	04S/09W-07P01 S	ORANGE 15	20001108	-7.6	18.4	11	17.0	0.008	22	<1E-9	<0.1	0.5
100779	05S/10W-03R03 S	SANTA ANA 35	20001107	-8.9	3.0	30	16.2	0.005	96	<1E-9	<0.1	3.4
100780	05S/10W-16B02 S	SANTA ANA 21	20001107	-8.4	1.2	>50	17.1	0.006	100	<1E-9	<0.1	2.9
100781	05S/10W-21B03 S	FOUNTAIN VALLEY 03	20001107	-8.5	-0.2	>50	17.5	0.004	100	<1E-9	<0.1	4.3
100782	04S/09W-31Q01 S	SANTA ANA 27	20001107	-7.6	10.4	24	19.9	0.016	76	<1E-9	<0.1	0.8

Table 1. A subset of analytical and calculated results from tritium and noble gas analyses for Los Angeles County and Orange County wells. (Cont.)

LLNL ID	State well ID	Owner ID	Sample date	$\delta^{18}\text{O}_{\text{smow}}$ (‰)	Tritium (pCi/L)	Age (years)	Recharge temperature (°C)	Excess air concentration (cm ³ -STP/g)	% Pre-modern	${}^4\text{He}_{\text{rad}}$ concentration (cm ³ -STP/g)	Apparent ${}^4\text{He}_{\text{rad}}$ age (k years)	chi ²
100783	05S/10W-02K02 S	SANTA ANA 24	20001107	-8.2	23.4	31	18.0	0.021	73	<1E-9	<0.1	4.5
100784	05S/09W-09C02 S	TUSTIN VANDENBERG	20001108	-8.0	3.3	87	19.9	0.027	100	1.66E-07	3.3	0.1
100785	05S/10W-28C09 S	FOUNTAIN VALLEY 10	20001108	-8.5	66.5	9	17.1	0.003	-186	2.12E-09	<0.1	4.3
100786	05S/09W-17B01 S	SANTA ANA 31	20001107	-7.5	5.9	20	21.4	0.017	83	<1E-9	<0.1	2.3
100787	03S/12W-14J01 S	PARK 46C	20001109	-8.4	35.2	22	18.6	0.009	9	<1E-9	<0.1	7.3
100788	01S/04W-02D08 S	NEWMARK SIERRA HIGH SCHOOL D8	20001128	-7.7	10.7	4	nc	0.011	57	<1E-9	<0.1	60.0

Notes:

ID = Identification.

 $\delta^{18}\text{O}_{\text{smow}}$ = Delta ¹⁸Oxygen relative to Standard Mean Ocean Water.

pCi/L = Picocuries per liter.

°C = Degrees Celsius.

cm³-STP/g = Cubic centimeters at standard temperature and pressure per gram. ${}^4\text{He}_{\text{rad}}$ = Radiogenic ⁴Helium.

k years = Thousands of years.

chi² = Goodness of fit to model.

nc = Not calculated.

ns = No sample.

Looking in greater detail at results from individual wells and groups of wells in the study area, the groundwater ages offer further insight into the patterns of flow and transport, and areas of vulnerability in each basin. For example, the wells upstream (to the north and northeast) of the Rio Hondo spreading area produce relatively young water, and must be recharged from a ‘natural’ source, other than the artificial recharge ponds. Wells within 5 kilometers or so of the Talbert Gap injection barrier, operated by the Orange County Water District (OCWD), have younger ages than surrounding wells, signaling the presence of the injected water. Similarly, the influence of the West Coast Basin Barrier is evident in six wells near the Manhattan Beach coast, which contain tritium not present in neighboring wells.

A group of four wells in the City of Tustin (indicated in Figure 1b) are exceptional in nearly all of the parameters measured for this study. Deep, nearby, monitoring wells produce water at elevated temperatures of up to 60° C (Roy Herndon, OCWD, personal communication). While these wells produce mixed water, like nearly all the wells sampled, the Tustin wells have a unique component of dissolved gas, derived from an extremely deep-seated source, which carries an isotopic signature from the earth’s mantle. Reliable ³H-³He groundwater ages cannot be determined for these wells.

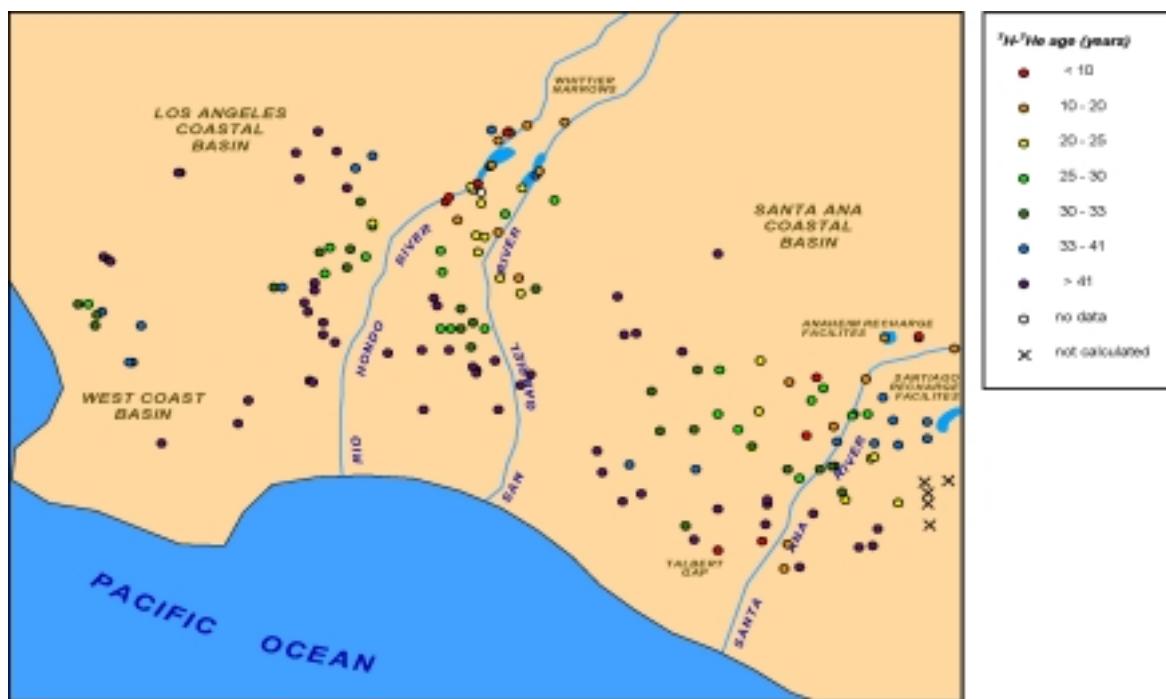


Figure 1b. Tritium-helium groundwater age measured in drinking water wells from Los Angeles County and Orange County. A general pattern of increasing age away from the artificial recharge areas is observed, with approximately 1/3 of the samples in the distal region having ages > 50 years. Injection barriers at the Talbert Gap and Dominguez Gap are evidenced by younger ages. Four wells in the Tustin area show a clear mantle-derived helium component and ages are not calculated.

Fewer ‘young’ ages (less than 15 years, and 15 to 25 years) were found in the Santa Ana Basin wells compared to the LA County Basin, probably because fewer wells very near the recharge ponds were sampled. Downgradient from the recharge facilities, zones of fast-moving

groundwater are indicated by regions where tritiated water reaches nearly 8 miles (LA Basin) and nearly 12 miles (Santa Ana Basin) downgradient from the recharge facilities. In contrast, ‘dead’ zones, where artificially recharged groundwater is not flowing rapidly to replace ambient groundwater, exist between the two basins, and in areas lateral to the recharge ponds. Long term, basin-wide, bulk flow rates of 600 to 1,200 ft/yr can be estimated from the boundary of tritiated water. In an extensive groundwater age and tracer study in the forebay area of the Orange County Water District (artificial recharge facilities include 4 lakes in the Anaheim area and an extensive array of monitoring wells), groundwater flow rates were found to decrease to the west (as distance^{-1/3}), away from the recharge ponds (Davisson et al., 2002; Clark et al., 2002). This is anticipated, since basin width and depth increases in the same direction. The zone of fast flow southwest of one of the ponds, Kraemer Basin, also identified in the present study, was delineated in more detail, with ages of less than two years found nearly 2 miles away from the ponds. An examination of cross-sectional data reveals that relatively young groundwater penetrates the entire thickness of the basin in the forebay area of the Santa Ana Coastal Basin. The vertical transit time in the Orange County forebay is approximately 10 years (Clark et al., 2002).

Artificial tracers that were introduced into the OCWD recharge ponds allowed detailed examination of flow in the first 2 years after recharge (the period of observation). Flow rates determined by tracking tracer movement roughly agreed with flow rates derived from near-field age data (6,000 to 10,000 ft/yr). In this part of the basin, the sampling density (in both time and space) is high enough to calculate vertical and horizontal hydrodynamic dispersion using these tracer data. These coarse-grained alluvial sediments give rise to a highly dispersive regime, with a calculated horizontal dispersivity of 50%. This high dispersivity has significant bearing on contaminant concentrations that will be observed at a well. Not only do long-screened wells dilute a contaminant by drawing water of mixed age in the vertical sense, but horizontal dispersion during transport mixes in front of and behind the source, resulting in a decreased concentration at the well.

Four sets of nested multi-level monitoring wells from the Los Angeles Basin (Figure 2), which have comparatively narrow screened intervals, were sampled and analyzed, and provide further insight into the pattern of groundwater flow in the vertical dimension. The Rio Hondo and Pico-Rivera monitoring wells are situated just adjacent to the Rio Hondo and San Gabriel spreading areas, respectively. In the Rio Hondo wells, groundwater mean ages increase steadily with depth (Figure 2), from a mean age of 2 years in the well with the most shallow screened interval, to >50 years (no tritium) in the deepest well. Pico-Rivera wells exhibit a similar pattern of increasing age with depth, but the young water penetrates to a greater depth in that area, and the deepest zone has a mean age of 21 years. Further downgradient, the Downey monitoring wells have older ages, with the shallowest well having a mean age of 17 years. The combined effects of aging (radioactive decay) and dispersion result in older mean ages along flow paths. The Lakewood monitoring wells, in the distal region of the basin, are tritium-free below the uppermost level, which has a mean age of 25 years. Limited downward vertical transport in the distal region of the basin is evident from the monitoring well results. Furthermore, these data suggest that the horizontal transport rate decreases with increasing depth in the basin, an important consideration for 3-dimensional numerical modeling of flow.

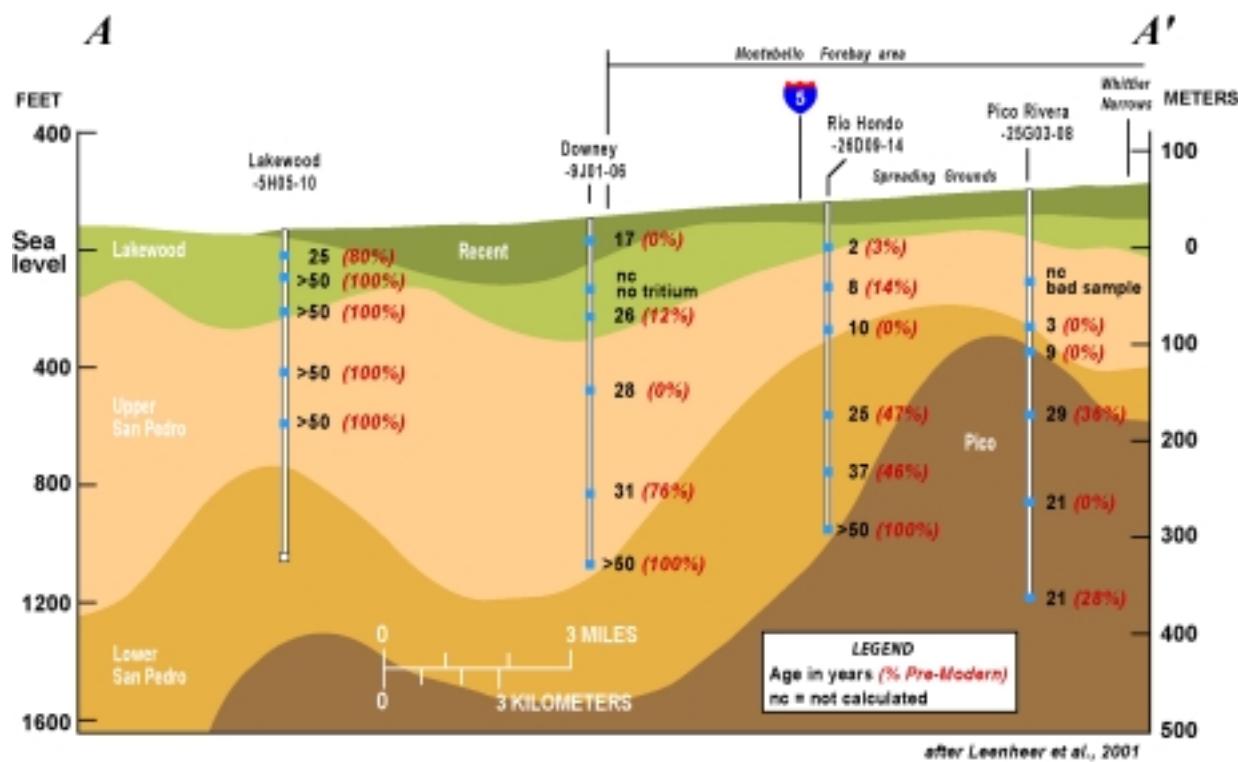


Figure 2. A cross section through the Los Angeles County Basin (after Leenheer et al., 2001) and four nested monitoring wells (screened intervals shaded) where tritium-helium ages and associated parameters were measured. A pattern of increasing age and increasing fraction pre-modern water with depth is observed. Of note are the great depths at which post-modern water is present in the Pico-Rivera wells, and the very low level of tritium (giving a mean age of 25 years) observed in only the shallowest interval at the distal Lakewood wells.

As noted above, the ages reported here are the mean of a mixed age, which may have a broad distribution, especially since the groundwater is in most cases produced from wells with very long screened intervals. Figures 3a, 3b, and 4 can be used to de-convolute the mixed age, and give a rough estimate of the fraction of water older than about 50 years that is produced at a given well. Figure 3a is a plot of 'initial' tritium (or the tritium concentration at the time of recharge) versus the measured mean age. The tritium that was present at the time of recharge, also shown, is fairly well defined from measurements of tritium in precipitation at several sites in North America. Water that recharged before about 1955 now contains very low levels of tritium due to radioactive decay. A groundwater sample for which the measured age gives a decay-corrected tritium value that falls on or near the curve does not have a significant component of water that dilutes the tritium in the sample. Samples that fall below the 'initial tritium' curve contain a fraction of water that recharged before 1955 ('pre-modern'). (The two points that fall well above the curve in Figure 3b are from the Talbert Gap injection barrier and contain tritium from industrial and/or medical waste stream sources.) The fraction of pre-modern water for samples that fall below the curve is estimated from the difference between the predicted and measured tritium at the calculated water age (Figure 3b). The fact that most of the Los Angeles Basin and Santa Ana Basin samples fall well below the initial tritium curve indicates that a

significant component of older water is produced from these wells, and that the mean ³H-³He age that is reported really represents a broad age distribution.

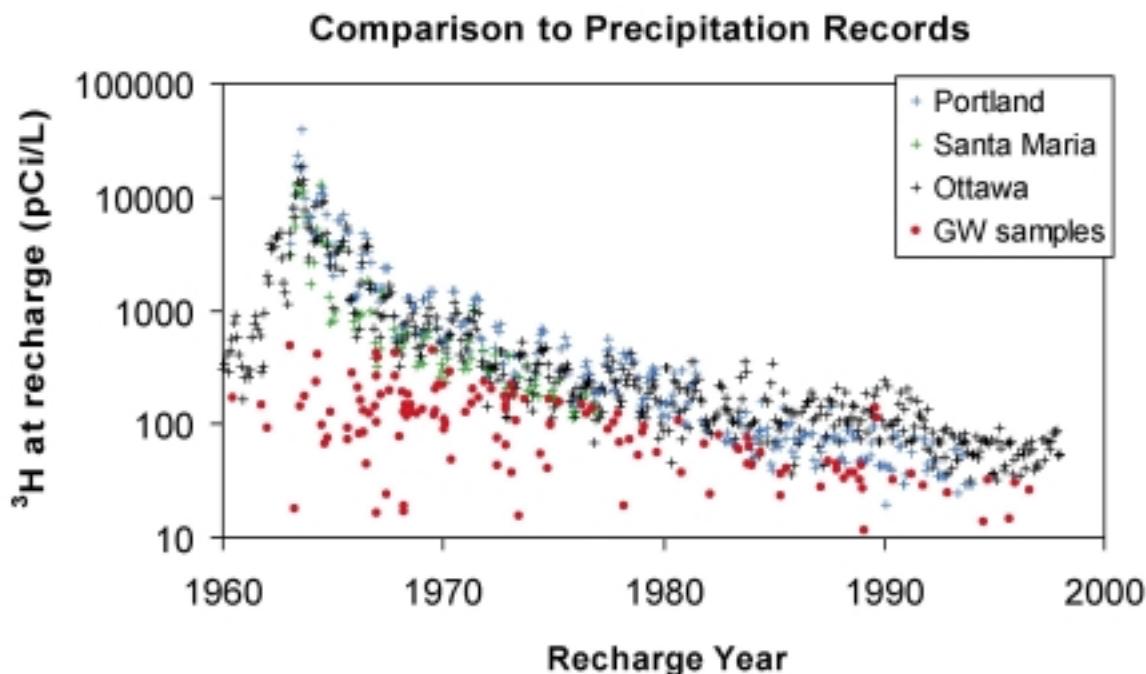


Figure 3a. Small symbols show tritium measured in precipitation for the last several decades at the locations indicated. Atmospheric nuclear weapons testing peaked in 1963, just before the atmospheric test ban, and tritium in the atmosphere has decreased steadily since then. Also shown are initial tritium concentrations at the time of recharge from well water samples (tritium is decay corrected according to the mean groundwater age). Samples that fall below the curve have a fraction of pre-modern, or 'tritium-dead' water.

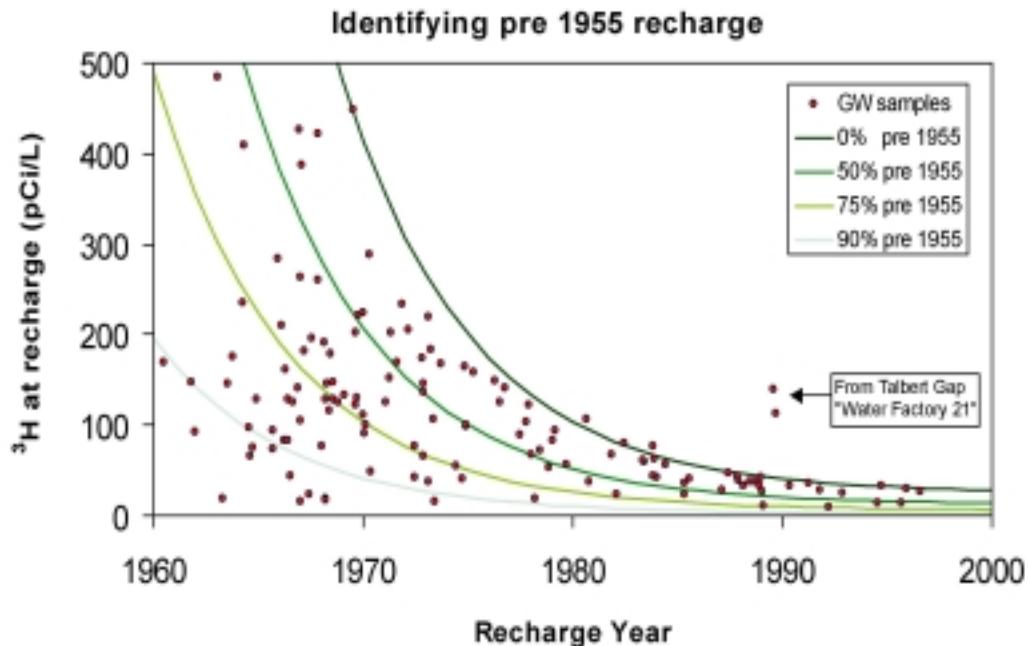


Figure 3b. An expanded version of Figure 3a, with curves showing equal percentages of pre-modern water. Many wells from the distal regions pump mostly pre-modern water. Two wells from the Talbert Gap, where treated wastewater is injected, show evidence for anthropogenic tritium, likely from an industrial or medical source.

Figure 4 shows the spatial distribution of the fraction of pre-modern water in the wells sampled. Wells where tritium is below the detection limit of 1 picocurie per liter (pCi/L) (\pm approximately 1 pCi/L) produce water that is greater than 99% pre-modern. The overall pattern observed is similar to the spatial distribution of ages, with smaller fractions of pre-modern water closer to the recharge facilities. A significant number of the Los Angeles Basin wells have relatively narrow age distributions, with measured tritium values that fall close to the initial tritium curve. In general, these wells fall along the ‘fast’ flow paths identified on Figure 1b. Multi-level monitoring wells near the recharge facilities have very low fractions of pre-modern water in shallow intervals, with the fraction pre-modern increasing with depth. Santa Ana Basin wells frequently (especially in the eastern portion of the basin) produce a large fraction of pre-modern water, with very low measured tritium concentrations. These results indicate that, with the exception of a small number of wells near the recharge facilities, the wells in these basins produce water that is greater than 50% pre-modern, and that any industrial-aged (or ‘post-modern’) signal will be diluted by at least that factor.

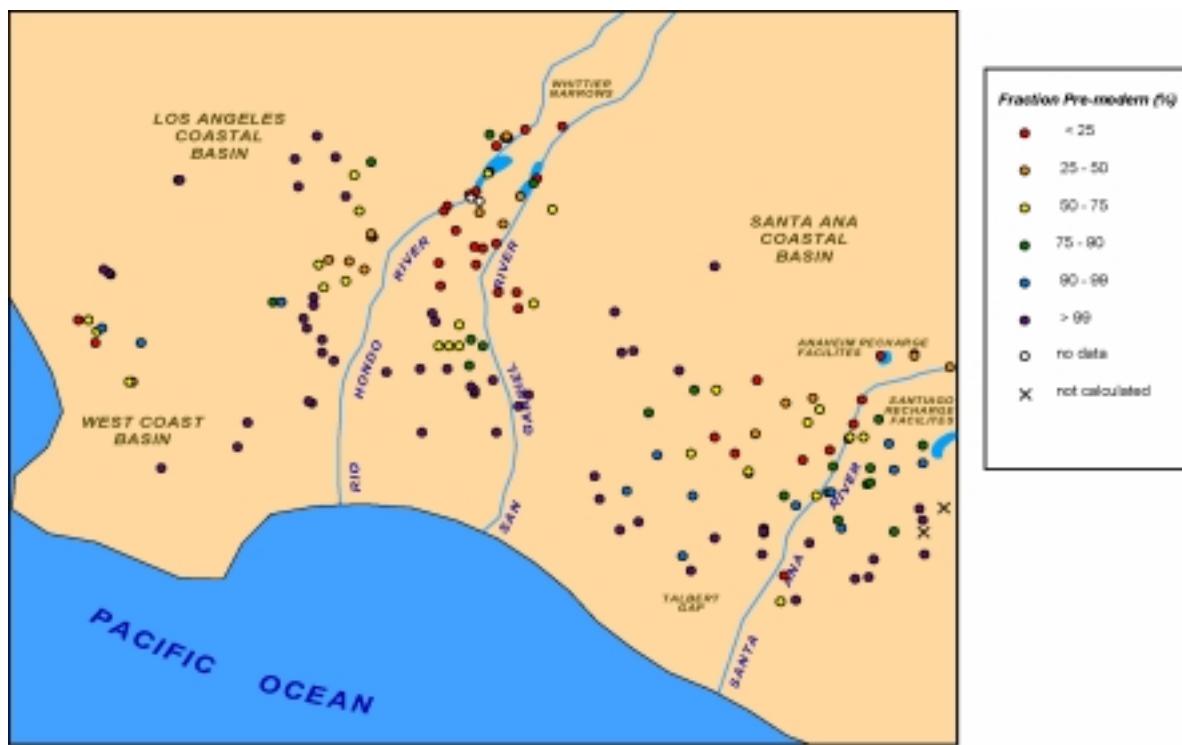


Figure 4. Map view of percent pre-modern calculated in each well. The pattern observed is much like that observed for groundwater age, with areas furthest from active recharge areas showing the largest fractions pre-modern water.

1.2.2. Radiogenic ⁴Helium (⁴He_{rad})

The characteristics of the pre-modern water fraction can be further examined by analyzing another facet of the dissolved He that can be derived from detailed analysis of dissolved noble gases. The concentration of ⁴He, a stable isotope of helium, in groundwater, gives additional information on subsurface residence time, at time scales greater than a few hundred years. ⁴He accumulates in groundwater due to the decay of uranium and thorium in the earth's crust. Precise age dating using ⁴He is not possible because the accumulation rate depends on myriad factors, but groundwater older than a few hundred years usually has detectable ⁴He_{rad} (e.g., Solomon et al., 1996; Castro et al., 2000). This ⁴He_{rad}, derived from U and Th decay, must be distinguished from ⁴He that is due to equilibrium solubility, and that which comes from trapped air bubbles entrained during recharge, which subsequently dissolves in the groundwater. The measured Neon concentration (assumed to be derived solely from the atmosphere) is used to calculate the additional He.

⁴He was found in about half of the wells in the Los Angeles Coastal Basin and in about one third of the wells in the Santa Ana Basin, at concentrations that indicate the presence of a component of the groundwater that is hundreds to hundreds of thousands of years old (Figure 5). These data serve to corroborate the notion that these long-screened wells draw in water with a broad age distribution, which has a long tail toward very old age. In general, ⁴He_{rad} follows the same pattern as the other parameters, i.e., wells with older mean ages and greater fractions of

pre-modern water contain higher ${}^4\text{He}_{\text{rad}}$ concentrations. The highest ${}^4\text{He}_{\text{rad}}$ concentrations occur along the eastern edge of the Santa Ana Coastal Basin (the Tustin wells have extremely high levels and present an exception as noted above), and in the lateral and distal regions of the Los Angeles Coastal Basin. Much of the water produced from these wells recharged the aquifer hundreds to thousands of years ago, probably from a great distance away. The implications for water resource management are that these wells produce a significant volume of water that is ‘mined’, and would not be recharged naturally for hundreds or thousands of years. The high current recharge rate mitigates this water balance concern.

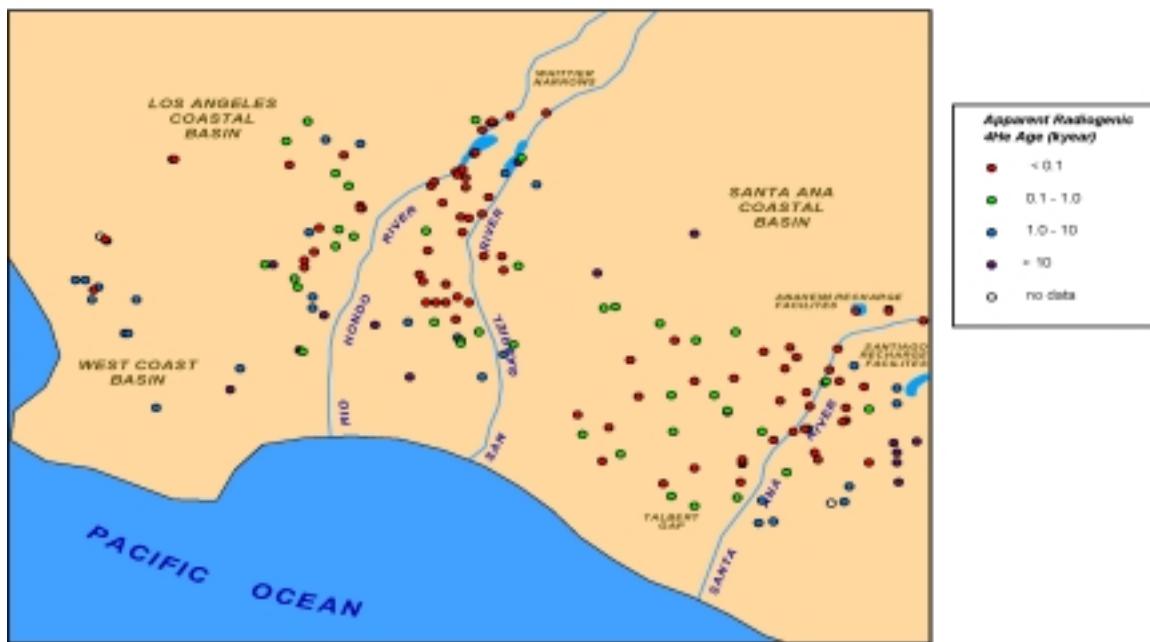


Figure 5. Apparent ${}^4\text{He}_{\text{rad}}$ age calculated from the ${}^4\text{He}_{\text{rad}}$ concentration at each of the wells in the study. Green, blue and violet symbols indicate areas where a fraction of the water drawn is greater than 100 years old.

1.2.3. ‘Excess Air’

During transport through a vadose zone, and during changes in the level of the water table, infiltrating water may entrain or trap air bubbles that subsequently dissolve in groundwater. This dissolved gas component is termed ‘excess air’. The concentration of excess air supplies useful information about the recharge process, and is an important consideration during reduction of dissolved noble gas data to the calculated age. Excess air concentrations, derived from excess Ne, are shown in Figure 6. The artificial recharge operations that take place at the Rio Hondo and San Gabriel areas of the Los Angeles Basin and at the Anaheim Lake and Santiago Creek areas of the Santa Ana Basin, are likely to affect the amount of dissolved excess air observed in groundwater recharged from those facilities. The recharge ponds are allowed to dry, and sediments that have accumulated on the bottoms and sides of the ponds are removed, to allow higher infiltration rates. Water is loaded into the ponds in a pulse of short duration, and a large groundwater mound is established beneath the ponds. Thus, the water table rises and falls over a short time frame, by several tens of feet. This recharge mechanism is likely to trap a great deal

of excess air. Compared to published values (0.001 to 0.01 cubic centimeters at standard temperature and pressure per gram of water ($\text{cm}^3\text{STP/g}$); Aeschbach-Hertig, et al., 2000), the excess air concentrations found in these public supply wells are near the upper end of the observed range. (Dissolved oxygen (DO) concentration would also be relatively high in the infiltrating water, but high DO is not observed in well water samples. This pattern indicates that DO is efficiently consumed just subsequent to recharge, probably during breakdown of organic matter. A significant decrease in total organic carbon has been documented for recharging water in OCWD facilities [Davisson et al., 1998].)

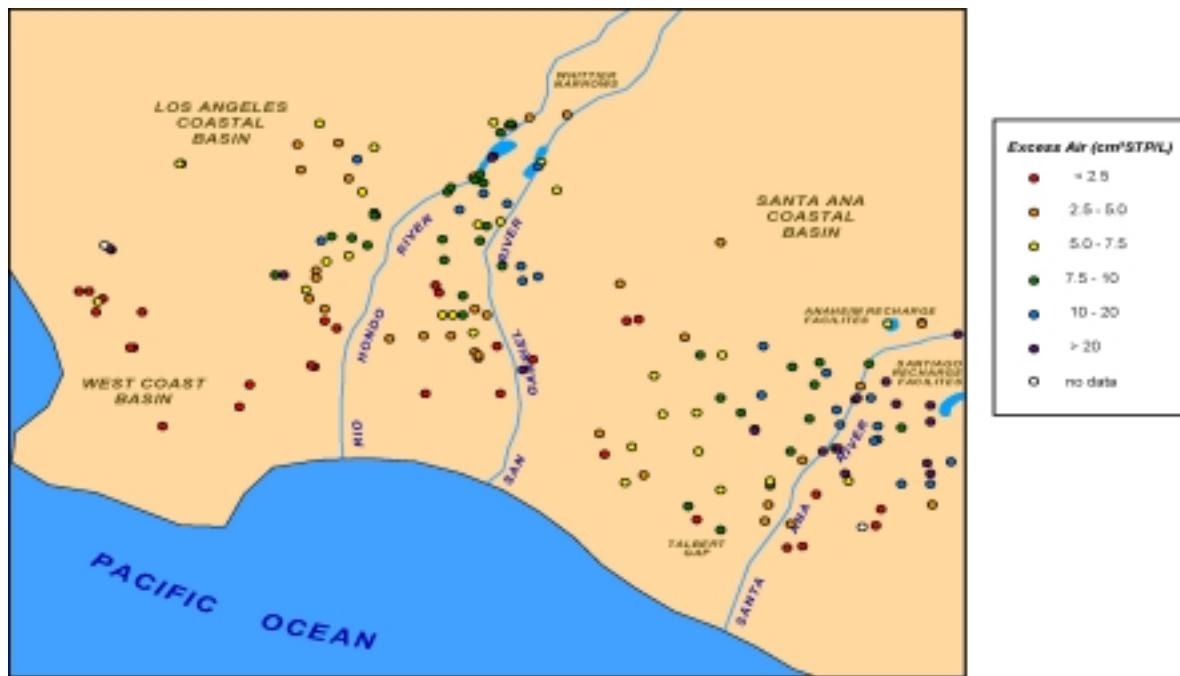


Figure 6. The spatial distribution in the concentration of ‘excess air’ (see text for definition) observed in the dissolved gas samples. Higher concentrations of excess air are found closer to the recharge facilities because the artificial recharge operations cause large fluctuations in the water table, which induces air bubble entrainment during recharge

In Figure 6, one sees that the highest levels of excess air are generally recorded in wells close to the recharge ponds, with wells in distal portions of the basin having much lower excess air concentrations. In the Los Angeles Basin in particular, the same groups of wells that have young mean ages, low fractions of pre-modern water, and low ${}^4\text{He}_{\text{rad}}$ concentrations, have high levels of excess air. A large component of the water produced at these wells has been transported, relatively quickly, from the artificial recharge ponds in the forebay area of the basin. Wells with comparatively low excess air concentrations, which are fewer in number, likely have a large component of water that recharged under natural conditions. Several of the noble gas-derived parameters, including excess air, indicate that ‘native’ groundwater is present in the distal region of the Los Angeles Basin. This is apparently the only large area in the region where there is an archive of native groundwater.

1.2.4. Recharge Temperature

Another key parameter that is calculated from the measured dissolved noble gas concentrations is the temperature at which recharge took place (often related to the altitude of recharge). The solubility of noble gases in water is temperature-dependent, with He having the weakest dependence on temperature and Xe the strongest. By measuring the concentration of all of the dissolved noble gases and comparing the results to well-known temperature vs. solubility curves, one gets a robust estimate of the recharge temperature. The results for the Santa Ana and Los Angeles Basin wells are shown in Figure 7. Calculated recharge temperatures range from less than 15 degrees Celsius (15° C) in distal regions, to greater than 19° C in regions close to the recharge facilities. The mean annual air temperature in the vicinity of the recharge facilities is 18.7° C, with an annual variation of the mean over the last 20 years of 3° C (<http://www.giss.nasa.gov/>), while surrounding higher elevations, where some natural recharge takes place, experience a wider temperature range (variation of the mean of about 6° C), and lower mean annual temperatures (16° to 17° C). Once again, the pattern observed is related to the artificial recharge operations, whereby water transported to the low elevation recharge ponds is allowed to equilibrate at a warmer air temperature than the natural system would have dictated. In Figure 7, cooler recharge temperatures signal regions where groundwater is more likely to have recharged under natural conditions.

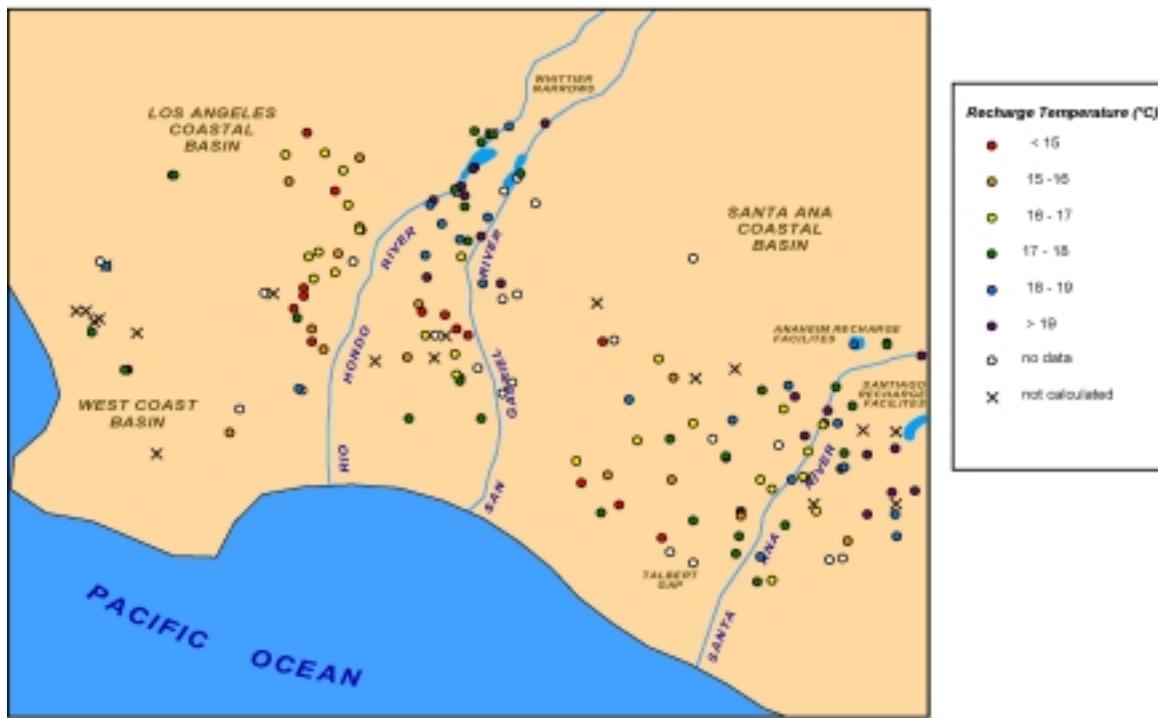


Figure 7. Recharge temperatures calculated from the concentrations of the dissolved noble gases. Higher recharge temperatures are observed closer to the artificial recharge facilities, as water is allowed to equilibrate at low elevation in ponds with large surface areas. Under natural conditions, a lower temperature is expected with recharge occurring in the surrounding high elevation areas.

1.2.5. Stable Isotopes as Tracers of Recharge Source

The minor stable isotopes of water molecules ²H (deuterium, denoted as D) and ¹⁸Oxygen (¹⁸O) vary in precipitation as a function of temperature, elevation and latitude (Craig, 1961; Ingraham and Taylor, 1991). In California, extreme changes in elevation occur over a relatively short distance. The net effect is that surface water from mountain watersheds has a significantly lower abundance of ¹⁸O and D than coastal water. The abundance of these isotopes in groundwater samples can provide clues as to the origin of the source water from which the groundwater is derived.

Oxygen isotope ratios are reported in the standard delta (δ) notation as parts per thousand (per mil or ‰) variations relative to a reference material of known composition and defined by the following equation:

$$\delta^{18}\text{O} = \left[\frac{(^{18}\text{O}/^{16}\text{O})_{\text{sample}}}{(^{18}\text{O}/^{16}\text{O})_{\text{standard}}} - 1 \right] \times 1000 \quad (2)$$

The conventional standard reference material for oxygen isotopes is Standard Mean Ocean Water (SMOW; Craig, 1961). Using the del notation, $\delta^{18}\text{O}$ in precipitation varies from approximately -5 ‰ along the Pacific coast to -15 ‰ in the Sierra Nevada Mountains. In the study area, locally-derived groundwater has a $\delta^{18}\text{O}$ range of -6 to -7.5 ‰. Sources of water imported to the region have much lighter $\delta^{18}\text{O}$ signatures, and include the Colorado River (-12 ‰) and California State Project Water (-10 ‰).

Shelton et al. (2001) used δD and $\delta^{18}\text{O}$ analyses in Los Angeles Basin public supply wells to delineate mixing between imported and locally-derived water. They found that wells with a higher frequency of occurrence of VOCs were more likely to have a stable isotope signature with a component of imported water. Hence, the effect of the artificial recharge operations in the Los Angeles Basin is evident, whereby artificially recharged water is more likely to be imported, and associated with VOC occurrence. We examine the spatial distribution of $\delta^{18}\text{O}$ from LLNL analyses in Figure 8, which shows a fairly complex pattern, related to both the source of water that is recharged, and the timing of recharge. In the LA Basin, wells with younger mean ages (closer to the recharge facilities) have $\delta^{18}\text{O}$ values that indicate a higher elevation (imported) source. Distal wells display a local or ‘natural’ $\delta^{18}\text{O}$ value of approximately -7 to -7.5 ‰. In the Santa Ana Basin, the pattern observed is nearly opposite, with distal wells generally exhibiting lighter $\delta^{18}\text{O}$ values. A plausible explanation for this difference is that the main source of recharge water to the OCWD ponds has changed over the past several decades – going from a large fraction of water imported from the Colorado River, to the present-day situation, in which most water used for artificial recharge is reclaimed water from the local watershed.

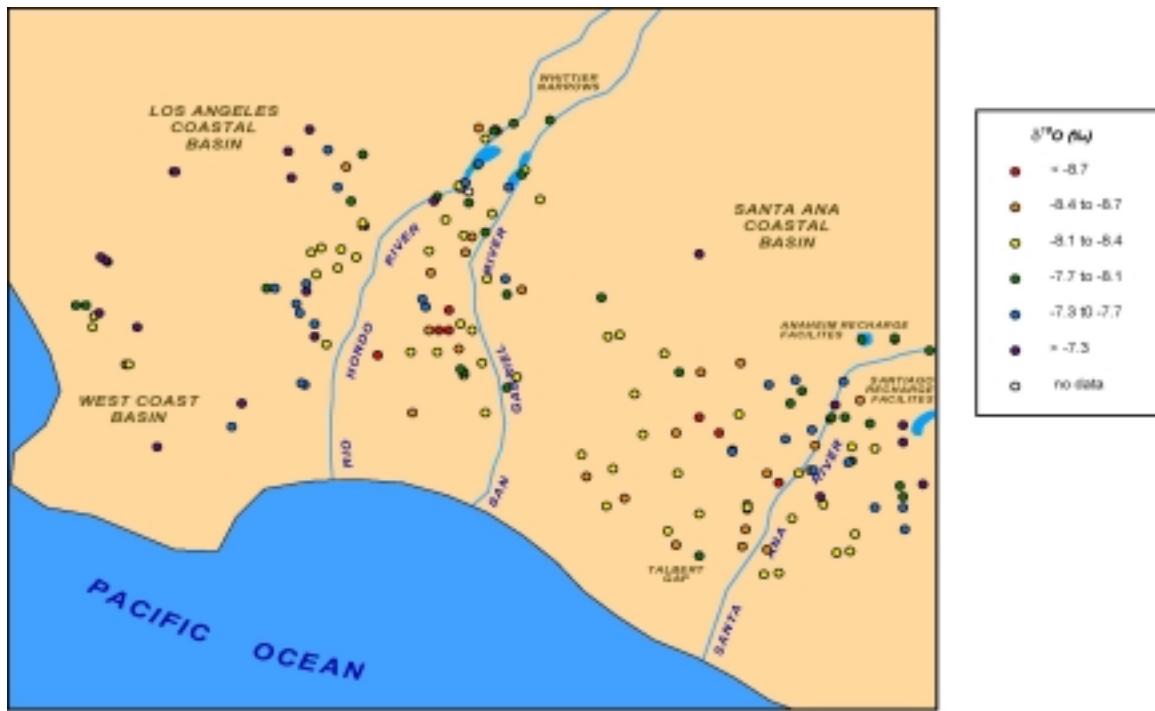


Figure 8. The spatial distribution in $\delta^{18}\text{O}$ values from the wells sampled shows a complex pattern related to the source of recharge water (imported versus local) and the changes in water source over the last several decades. In Orange County, the source of artificially recharged water has gone from mostly imported (more negative $\delta^{18}\text{O}$) to mainly local water captured in the watershed.

1.2.6. Comparison with USGS VOC Results

As noted above, results of low-level analyses of 85 VOCs, carried out by the USGS, for the sample set described here, are reported in Shelton et al., 2001. In general, the pattern observed in VOC occurrence closely follows the patterns observed in groundwater age and in the other derived parameters such as recharge temperature and percent pre-modern water. That is, VOC occurrence frequency is higher in wells with younger groundwater ages, and decreases with distance along flowpaths. While sources likely vary for the different compounds detected, it is clear that the flow field established by artificial recharge and pumping is transporting these low-level contaminants away from regions near the recharge areas. Of the 67 wells that are devoid of tritium (59 public supply wells and 8 monitoring wells), and hence > 99% pre-modern, 48 are also free of VOCs. This result confirms the notion that vertical transport in the distal region (or ‘pressure area’) of these basins is severely limited by thick clay confining units above the main aquifers.

Wells that defy the general pattern (young age and free or nearly free of VOCs, or old age with high frequency or concentration of VOCs), while few in number, are of interest with regard to the overall goal of assessing contamination vulnerability at individual wells or groups of wells. Of particular interest are wells that produce exclusively pre-modern water and have VOC detections. These are areas where the potential presence of a ‘short-circuit’ of some kind

(compromised well-casing, or a conduit that provides an unimpeded vertical pathway) is suspected. Of the 19 tritium-free wells where one or more VOC was detected (all public supply wells), 10 have detections only of CFC-11 (3 wells) or chloroform (3 wells) or both (the 4 Tustin wells). The CFC-11 concentrations detected are very low, while chloroform concentrations in these wells are relatively high, compared to concentrations found in other wells. Chloroform detections may be due to residual byproducts of chlorination or chloramination that takes place right at the wellhead, or during pump or well maintenance. This chloroform has therefore not been transported to the groundwater advectively, nor is it due to transport via a ‘fast path’. Another 8 tritium-free wells have relatively high trichloroethylene (TCE) occurrences, sometimes accompanied by tetrachloroethylene (PCE), and 1 well has benzene compounds. It is at these 9 wells (and perhaps at the 7 wells with CFC-11 detections), which are located in clusters in localized areas (e.g., 34.0N, -118.20W; 33.9N, -118.22W; and 33.71N, -117.86W), where the regional-scale pattern of vulnerability predicted by the groundwater ages, is not followed, and a vertical fast path likely exists. One of these three areas (34.0N, -118.20W; in the Raymond sub-basin of the Los Angeles Basin) has been demarcated as ‘vulnerable’ (DWR, 1943; shown in GeoTracker – <http://www.ecointeractive.geotracker3.com>) because observed infiltration rates in the area are higher than in surrounding areas.

Wells that have mean ages of < 15 years and no detectable VOC concentrations also defy the general pattern observed in the southern California basins. Two wells (EMA-AH2 upstream of the recharge facilities in the Anaheim area, and NB-DOLS near the Talbert Gap injection area), have mean ages of less than 15 years and 0 VOC detections and 2 other wells (Mesa 09 and Irvine 16, both near the Talbert Gap injection area) have mean ages of 15 to 22 years (and relatively low fractions of pre-modern water) with 0 VOC detections. While these wells (all in the Santa Ana Basin) may be considered more vulnerable than wells that produce older water, VOC occurrence is zero because sources do not exist, or are diluted to levels below the detection limits.

A plot of MtBE versus mean groundwater age for a subset of wells from the Los Angeles Coastal Basin, where a significant number of MtBE detections were observed, is shown in Figure 9. Wells where tritium was above the detection limit are shown, along with a line that represents a moving, 5-year average of the age. In general, higher MtBE concentrations and a greater likelihood of occurrence correlates with a younger mean age, although there is a good deal of scatter. MtBE was introduced into the environment (including a non-point source component due to equilibrium solubility between surface water and atmospheric MtBE) only in about the last 15 years, so its association with young groundwater is expected. Most wells with mean ages of greater than 25 years do not contain MtBE above the reporting limit. Three wells represent an exception, with mean ages of 26 to 39 years and significant MtBE concentrations. These wells may capture a subsurface point source component, or may be in an area where a vertical conduit exists.

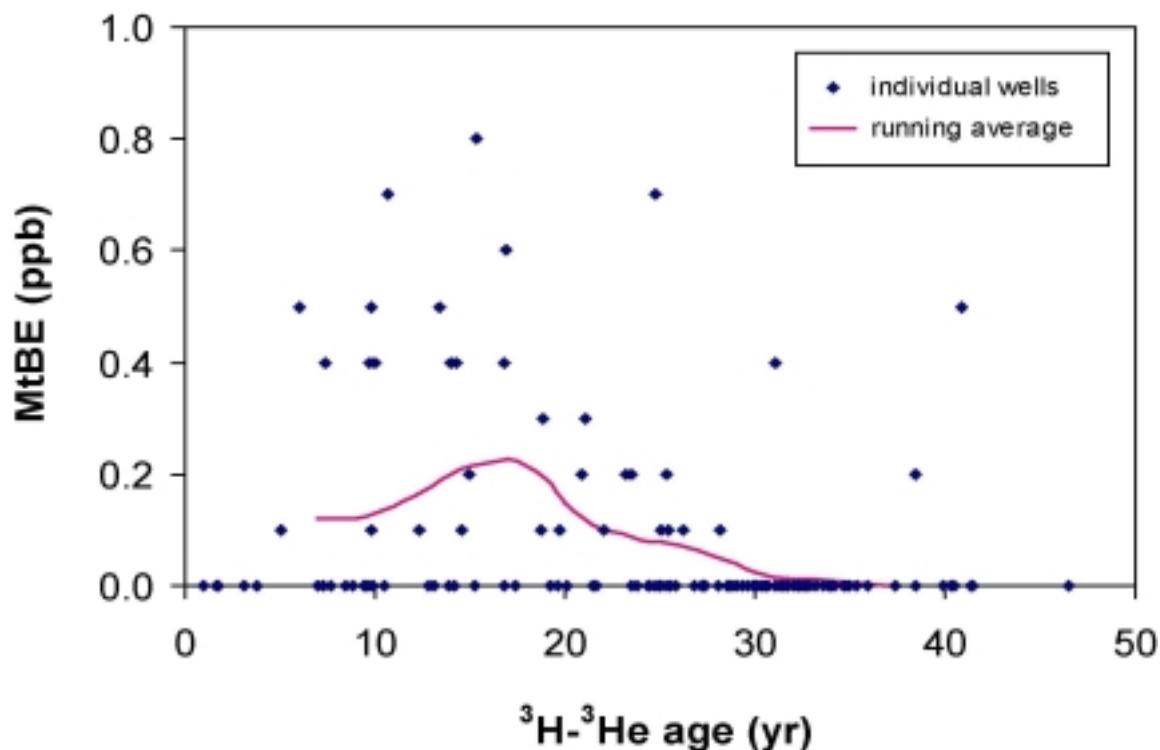


Figure 9. Measured groundwater age versus MtBE concentration (from Shelton et al., 2001), along with a five-year moving average of MtBE concentration. A general trend of decreasing MtBE concentration with increasing age is observed. The three points with ages >30 years and relatively high MtBE concentrations may be related to non-advectional transport of the contaminant ('short circuit').

1.3. Summary and Conclusions

Groundwater ages, and other parameters derived from noble gas analyses, have been used to assess groundwater vulnerability in the two large, intensively managed groundwater basins of southern California. The pattern of flow and transport in these basins is greatly influenced by artificial recharge of a huge volume of water at recharge facilities in the forebay areas, and by considerable groundwater pumping. Accordingly, mean groundwater ages are younger closer to the major artificial recharge facilities, and older in downgradient wells. Wells with comparably young mean ages can be classified as vulnerable, since water and associated contaminants of the industrial age reach these wells relatively quickly from surface and near-surface sources. Indeed, these are the same wells with comparably high frequencies of occurrence of low level VOCs (Shelton et al., 2001). A substantial number of wells (59 public supply wells of the 176 tested), in the distal regions of the flow field, are devoid of tritium, delineating a region where the groundwater produced at these wells recharged the aquifer more than about 50 years ago. This result indicates that vertical transport in the distal region (or 'pressure area') of these basins is severely limited by thick, continuous clay confining units above the main aquifers.

It is important to note that the mean ³H-³He ages reported here actually represent a broad age distribution, since most of the Los Angeles Basin and Santa Ana Basin waters analyzed from these wells have measured tritium values that indicate mixing between young water and a

significant component of water older than 50 years. With the exception of a small number of wells near the recharge facilities, the wells in these basins produce water that is greater than 50% pre-modern, and any industrial-aged signal will be diluted by at least that factor. Bulk mean flow rates for each basin, calculated using the boundary of tritiated groundwater, are 600 to 1,200 ft/yr, but flow rate clearly decreases with depth. Hydrodynamic dispersion plays a large role in mixing during transport of water and contaminants.

Dissolved noble gas analyses can also be used to calculate groundwater recharge temperature, ‘excess air’, and ${}^4\text{He}_{\text{rad}}$ (a measure of the presence of groundwater thousands to hundreds of thousands of years old). In general, these parameters follow the pattern observed for groundwater age, i.e., wells with young mean ages have smaller fractions of pre-modern water, and higher recharge temperatures, while wells with older mean ages and greater fractions of pre-modern water have higher ${}^4\text{He}_{\text{rad}}$ concentrations and lower recharge temperatures. These trends are all related to the recharge and flow patterns established by the engineered recharge facilities and pumping. Several of the noble gas-derived parameters, including excess air concentration, indicate that ‘native’ groundwater is present in the distal part of the Los Angeles Basin. This is apparently the only large area in the region where there is an archive of native groundwater.

1.4. Acknowledgements

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**Appendix A
Sampling and Analysis Plan
Lawrence Livermore National Laboratory**

Appendix A

Sampling and Analysis Plan Lawrence Livermore National Laboratory

A-1. Environmental Sample and QA Sample Collection

A-1.1. VOCs

After the well is purged, the sampling port is opened and water is allowed to pass through the port for two or more minutes, to allow purging of the sampling port. Vials are filled directly from the sampling port, without touching the bottle to the sampling port. A total of three samples, each in 40-milliliter (mL) volatile organic analysis (VOA) vials (VWR TraceClean™, amber borosilicate; 0.125-in. septa liner), are collected, with zero head-space. Non-volatile plastic or rubber surgical gloves will be worn by the sampler. Sample bottles are opened and filled away from any nearby exhaust from combustible engine sources, or open bottles of solvent. Emissions from regular street traffic are unavoidable in some cases, but should be noted form by sample collector. Two field blanks in 40-mL VOA vials are provided for each well sampled. One of the field blanks is topped-off by the other and capped with zero head space. The field blanks provide some measure of potential atmospheric contamination. Filled VOA vials are stored refrigerated at all times.

A-1.2. Stable Isotopes

A 30-mL glass bottle (clear, French-square type) with Qorpak™ polyseal-lined cap is triple rinsed with water directly from the sampling port, then filled just below the threads on the bottle. No preservatives or refrigeration are required, but the cap should be tightly closed.

A-1.3. Tritium

A 1-liter glass bottle (e.g., Pyrex with orange polypropylene plug seal cap) is filled directly from the sampling port to just below the threads. No preservatives are required.

A-1.4. Dissolved Noble Gas

Two clamped copper tubes for dissolved noble gas analysis are collected. Reinforced tygon tubing is attached to the well sampling port, with a copper tube dissolved gas sampling assembly connected by hose clamps. The assembly is purged of air by running well water through for several minutes. The sample is collected at the pressure of the distribution system (typically around 100 pounds per square inch). The tube or assembly is tapped lightly to knock any trapped bubbles free. Any air bubble that is sealed in the copper tube sample will compromise the sample. The downstream clamp is tightened first using a socket wrench. The bolts on either side of the clamp are tightened alternately so the copper is pinched evenly. The metal clamps are

completely closed. There will be a small gap in the center section of the clamp to prevent pinching off the copper tube completely. This center portion of the metal clamp is precisely designed for the correct gap on the copper tube when the outer portion of the clamps are in complete contact with each other. Samples are stored at room temperature.

A-2. Analytical Method—VOCs

The analytical technique of purge and trap gas chromatography-mass spectrometry (GC-MS) has been optimized to obtain low parts per trillion (ppt) reporting limits for several selected volatile organic compounds (VOCs): methyl tertiary butyl ether (MtBE) [5 ppt], toluene [5 ppt], tetrachloroethylene (PCE) [5 ppt], trichloroethylene (TCE) [5 ppt], 1,2-dibromo-3-chloropropane (DBCP) [5 ppt], trihalomethanes - chloroform [5 ppt], bromodichloromethane [5 ppt], and chlorodibromomethane [5 ppt]. Method detection limits (three times the standard deviation of seven replicate analyses of the blank) are between 0.3 and 1.2 ppt. The low detection limits are achieved, in part, by employing a heated purge to maximize the recovery of target analytes from the water samples, primarily needed for MtBE which has a relatively high aqueous solubility, and by operating the mass spectrometer in selected ion monitoring mode, an operating parameter which substantially increases the signal to noise ratio.

In this method, the target analytes are purged from 25 mL water samples and preconcentrated on a sorbent trap using a Hewlett Packard Model 7965 purge and trap concentrator equipped with a Vocarb™ 3000 trap. A 40°C heated purge is used and the samples are purged with a stream of ultrapure helium at a flow rate of 40 mL/minute- (min) for a duration of 11 min, followed by a 3-min dry purge. The analytes are desorbed from the trap at 260°C to a Hewlett Packard 6890 gas chromatograph equipped with a DB-624 column (60 mm × 0.32 mm ID, 1.8-µm (micrometers) film thickness), coupled to a Hewlett Packard 6890 mass spectrometer. The trap continues to bake at 260°C for an additional 20 min after desorption. The GC oven is temperature programmed as follows: 35°C held constant for 2 min, ramped at 10°C/min to a final temperature of 225°C, and held constant for 4 min. The mass spectrometer is operated in selected ion monitoring mode and three ion fragments are monitored for each compound, a primary ion used for quantitation and two secondary ions used for compound confirmation. The target analytes are identified by matching the retention times and the relative ratios of the three ion fragments to authentic standards and the compounds are quantified using the internal standard method. For MtBE, masses 43, 57, 73 are used for quantification. Neat standards of MtBE (spectroscopic grade @99.7%) are used for calibration, as well as a 4-bromofluorobenzene internal standard. Matrix blanks will be prepared in the laboratory and analyzed periodically bi-weekly as part of sample handling and analytical performance. Duplicate samples are analyzed with a frequency of 10%. Surrogate recovery (toluene-d8 and 4-BFB) must be between 80 and 120%.

Analytical Blanks are prepared by boiling double distilled water for 30 min and syringing into a VOA vial. The syringe is rinsed three times before use. This same blank water is used to prepare field blanks, by filling 40-mL VOA vials and capping with zero head space.

Analytical results greater than 5 ppt are reported to two significant figures. Well sample results for each compound are censored if field blanks from the same day have detections greater

than 5 ppt. In that case, results are reported as ‘<X,’ where X is the highest value measured for the given compound on the given day.

A-3. Analytical Method—Stable Isotopes

Oxygen isotope analyses are conducted using the carbon dioxide equilibration method for ¹⁸O/¹⁶O (Epstein & Mayeda, 1953) and analyzed with an automated water equilibration unit. Isotope ratio measurements are performed on a VG PRISM isotope ratio mass spectrometer housed in the Analytical and Nuclear Chemistry Division at Lawrence Livermore National Laboratory. Oxygen isotope ratios are reported in the standard delta (δ) notation as parts per thousand (per mil or ‰) variations relative to a reference material of known composition and defined by the following equation:

$$\delta_x = 1000 \frac{R_x - R_{std}}{R_{std}} \quad (\text{A-1})$$

where R_x is the ¹⁸Oxygen/¹⁶Oxygen (¹⁸O/¹⁶O) ratio of the sample. The conventional standard reference material for oxygen isotopes is Standard Mean Ocean Water (SMOW; Craig, 1961).

Analyses in the Stable Isotope Laboratory are calibrated to internal standards referenced against National Institute of Standards and Technology (NIST) standard reference materials. Internal standards consist of (1) Pacific Ocean water sample $\delta^{18}\text{O} = +0.35\text{\textperthousand}$, (2) two isotopically distinct California meteoric water samples $\delta^{18}\text{O} = -9.78$ and $-14.62\text{\textperthousand}$, and (3) Alaskan Tap Water ($-21.02\text{\textperthousand}$). The composition and isotopic values of these internal standards span the range of natural waters typically observed in potable groundwater of California. For each 24 $\delta^{18}\text{O}$ analyses, 2 each of 3 internal standards are also analyzed and used for calibration.

The internal standards are periodically compared to the three NIST reference standards: SMOW, Standard Light Antarctic Precipitation (SLAP), and Greenland Ice Sheet Precipitation (GISP). The analytical precision for these $\delta^{18}\text{O}$ measurements, from one run to the next, is $\pm 0.10\text{\textperthousand}$, which is defined in terms of the difference of the internal standard from the precisely known NIST standards. One duplicate is analyzed for every eighteen samples. These duplicates are not “blind” however, but are typically samples from the previous run. If this duplicate varies by more than $\pm 0.10\text{\textperthousand}$, the sample is run for a third time. If this duplicate is not with the 0.10‰ precision, the entire set of eighteen samples is re-analyzed.

A-4. Analytical Method—Tritium and Dissolved Noble Gases

The following analyses are reported for each groundwater well:

Tritium (³H in picoCuries per liter [pCi/L])

⁴Helium (⁴He), neon (Ne), argon (Ar), krypton (Kr), Xenon (Xe) abundances (in atoms per gram).

Tritium-³helium (³H-³He) age (in years)

Radiogenic ⁴Helium (⁴He_{rad}) (in atoms per gram)

Excess air (in cubic centimeters at standard temperature and pressure (STD) per liter)

Recharge temperature (in °C)

Chi² fit to excess air model of Aeshbach-Hertig (1999)

In the lab, each sample tube is attached to a 250-ml bottle assembly that is part of a multiport gas-handling manifold. The samples are released by unbolting the bottom clamp. The tubes are heated and then the water is frozen using frozen carbon dioxide. The dissolved gases are released into the previously evacuated headspace in this process.

Reactive gases are removed with a SAES Ti-Al getter operated at 400° C. Ar, Kr, and Xe are collected on activated charcoal using liquid nitrogen. At this point, a small portion (5%) of the remaining gas phase (He and Ne) is analyzed using a quadrupole mass spectrometer in order to measure the He/Ne ratio and to determine whether excessive He is present in the sample. The remaining He and Ne are then collected at 15 degrees Kelvin (15° K) on activated charcoal. The low temperature charcoal trap is then warmed to 35° K and the He is released and admitted to the VG 5400 mass spectrometer.

The mass spectrometer uses a conventional 17-stage electron multiplier and a SR400 pulse counting system for measuring ³He. ⁴He is measured using a faraday cup with a 10¹¹ Ohm feedback resistor. The procedure is calibrated using water samples equilibrated with the atmosphere at a known temperature (21° C). These calibration samples are processed along with regular samples with a frequency of 10%. Blind duplicate samples are analyzed with a frequency of 10%. The ⁴He and Ne abundances are measured with an accuracy of 2% and the ratio of ³He/⁴He is measured with an accuracy of 2%.

The Ar abundance is determined by measuring its total pressure using a high-sensitivity capacitive manometer. The Kr and Xe abundances are determined using the quadrupole mass spectrometer. The Ar abundance is measured with an accuracy of 2% and the Kr and Xe abundances are measured with an accuracy of 5%.

The measured abundances of Ne, Ar, Kr, and Xe are used to determine the amount of air-derived He present in the sample. The amount of ⁴He_{rad} and tritiogenic ³He (³He_{trit}) are determined by subtraction of the atmosphere component.

For tritium determinations, 500 gram (g) samples are loaded into stainless-steel bottles and attached to a multiport gas-handling manifold. The samples are frozen with liquid nitrogen and headspace gases are pumped away. Samples are then heated with valves closed to re-equilibrate the water and the headspace void. Samples are then re-frozen and headspace gases are pumped away. In each cycle, approximately 99% of the He is removed. After five cycles, virtually no ³He remains (< 100 atoms). The ³He from tritium decay is allowed to accumulate for about 10 days. The samples are heated and then frozen and headspace gases are analyzed to determine the amount ³He in-growth. Samples are analyzed in a similar fashion as the dissolved gas samples except that Ne, Kr, and Xe are not analyzed.

The procedure is calibrated using samples with known amounts of tritium. The NIST-4361-B tritium standard is used for the calibration standard. These standard tritium samples are processed identically to the well water samples and run with a frequency of 10%. Empty bottle blanks are run with a frequency of 10%. Blind duplicate samples are analyzed the frequency of 10%. Tritium accuracy is the quadratic sum of 1 pCi/L plus 5%. Tritium detection limit is 1-pCi/L. Groundwater age is calculated, and reported with a propagated analytical uncertainty.

A-5. References

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Appendix B

Analytical and Calculated Results for the

Full Suite of Dissolved Noble Gas and

Tritium Analysis, Including Analytical and

Propagated Errors

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.													
7		Well		Sample	Dissolved gas	Tritium	Collection	Dissolved gas	Tritium	At collection		At dissolved		
8	LLNL ID#	type	Well name	collection date	analysis date	analysis date	date	analysis date	analysis date	time	+-	gas meas time		
9										³ H (pCi/L)	(pCi/L)	³ He/ ⁴ He		
10	100575	MW	NEWMARK SBVMWD 1	20000621	200109290049	200111271834	06/21/00	09/29/01	11/27/01	6.4	0.4	1.29E-06	1.29E-08	5.60E-08
11	100576	MW	NEWMARK SIERRA HIGH SCHOOL D7	20000622	200109281924	200111292217	06/22/00	09/28/01	11/29/01	6.7	0.4	1.24E-06	1.24E-08	6.37E-08
12	100577	MW	SANTA ANA RIVERVIEW	20000711	200110021914	200111292300	07/11/00	10/02/01	11/29/01	22.7	1.0	1.80E-06	1.80E-08	1.69E-07
13	100578	MW	SANTA ANA RIVERVIEW	20000713	200109290238	200111262151	07/13/00	09/29/01	11/26/01	12.5	0.4	1.40E-06	1.40E-08	1.32E-07
14	100579	MW	LAKEWOOD 2	20000814	200109121839	200111262023	08/14/00	09/12/01	11/26/01	0.9	0.8	1.23E-06	1.23E-08	6.87E-08
15	100580	MW	LAKEWOOD 6	20000815	200110241509	200111271706	08/15/00	10/24/01	11/27/01	9.9	0.5	1.72E-06	1.72E-08	7.56E-08
16	100581	MW	LAKEWOOD 3	20000814	200109122215	200111292005	08/14/00	09/12/01	11/29/01	0.0	0.2	1.21E-06	1.21E-08	6.95E-08
17	100582	MW	LAKEWOOD 4	20000815	200109121312	200111272129	08/15/00	09/12/01	11/27/01	0.4	0.2	1.19E-06	1.19E-08	7.07E-08
18	100583	MW	DOWNEY 1-02	20000821	200107280057	200108162230	08/21/00	07/28/01	08/16/01	20.6	1.3	2.40E-06	2.40E-08	8.03E-08
19	100584	MW	DOWNEY 1-05	20000817	200109130004	bottle broken	08/17/00	09/13/01				1.95E-06	1.95E-08	6.25E-08
20	100585	MW	LAKEWOOD 5	20000816	200109121501	200111292133	08/16/00	09/12/01	11/29/01	0.1	0.2	1.25E-06	1.25E-08	7.52E-08
21	100586	MW	DOWNEY 1-06	20000822	200110270804	200111292049	08/22/00	10/27/01	11/29/01	38.8	1.5	1.94E-06	1.94E-08	9.69E-08
22	100587	MW	DOWNEY 1-03	20000822	200109131621	200111291838	08/22/00	09/13/01	11/29/01	88.0	3.3	4.48E-06	4.48E-08	9.19E-08
23	100588	MW	DOWNEY 1-04	20000822	200107272117	200108191040	08/22/00	07/27/01	08/19/01	46.1	2.0	2.87E-06	2.87E-08	8.43E-08
24	100589	MW	SOUTH GATE 05	20000824	200109140514	200108171704	08/24/00	09/14/01	08/17/01	0.1	0.5	1.36E-06	1.36E-08	6.96E-08
25	100590	MW	DOWNEY 1-01	20000817	200109132151	200111271918	08/17/00	09/13/01	11/27/01	-0.1	0.3	1.41E-06	1.41E-08	6.05E-08
26	100592	MW	SOUTH GATE 03	20000824	200110261926	200108161716	08/24/00	10/26/01	08/16/01	73.9	2.4	4.14E-06	4.14E-08	9.91E-08
27	100596	MW	SOUTH GATE 02	20000823	200109140324	200111272002	08/23/00	09/14/01	11/27/01	52.6	2.0	2.86E-06	2.86E-08	8.95E-08
28	100597	MW	SOUTH GATE 04	20000823	200109132000	200110122208	08/23/00	09/13/01	10/12/01	40.5	1.6	2.48E-06	2.48E-08	9.51E-08
29	100600	MW	RIO HONDO 1	20000907	200109132342	200111291922	09/07/00	09/13/01	11/29/01	0.2	0.2	1.11E-06	1.11E-08	1.10E-07
30	100601	MW	RIO HONDO 4	20000906	200109131810	200111272046	09/06/00	09/13/01	11/27/01	23.9	1.0	1.55E-06	1.55E-08	9.78E-08
31	100603	MW	PICO 2-1	20000911	200110161352	200110122337	09/11/00	10/16/01	10/12/01	26.8	1.3	2.01E-06	2.01E-08	7.70E-08
32	100604	MW	RIO HONDO 5	20000906	200109041546	200108161801	09/06/00	09/04/01	08/16/01	20.0	1.2	1.49E-06	1.49E-08	8.72E-08
33	100605	MW	SANTA ANA CONE CAMP 1	20000807	200109282301	200111271750	08/07/00	09/28/01	11/27/01	4.9	0.4	1.59E-06	1.59E-08	1.21E-07
34	100606	MW	RIO HONDO 2	20000907	200109050613	200108162315	09/07/00	09/05/01	08/16/01	59.0	2.0	4.38E-06	4.38E-08	9.16E-08
35	100607	MW	PICO 2-2	20000912	200109271601	200110130022	09/12/00	09/27/01	10/13/01	40.9	1.7	2.29E-06	2.29E-08	8.71E-08
36	100608	MW	PICO 2-5	20000914	200109280253	200110121955	09/14/00	09/28/01	10/12/01	25.5	1.2	1.46E-06	1.46E-08	7.35E-08
37	100609	MW	PICO 2-4	20000913	200109271749	200110121911	09/13/00	09/27/01	10/12/01	24.7	1.1	1.56E-06	1.56E-08	8.00E-08
38	100610	MW	PICO 2-6	20000912	200110170428	200110122124	09/12/00	10/17/01	10/12/01	30.2	1.3	1.21E-06	1.21E-08	4.24E-07
39	100611	MW	PICO 2-3	20000913	200109271413	200110122040	09/13/00	09/27/01	10/12/01	44.7	1.8	1.97E-06	1.97E-08	1.79E-07
40	100612	MW	RIO HONDO 6	20000906	200109272127	200110122253	09/06/00	09/27/01	10/12/01	25.8	1.3	1.43E-06	1.43E-08	8.58E-08
41	100614	MW	RIO HONDO 3	20000906	200110161729	200108171622	09/06/00	10/16/01	08/17/01	26.2	1.4	1.91E-06	1.91E-08	1.10E-07
42	100716	MW	NEWMARK SBVMWD 4	20000620	200109282112	200110301831	06/20/00	09/28/01	10/30/01	12.8	1.0	1.15E-06	1.15E-08	6.32E-07
43	100717	MW	SANTA ANA COMMERCE	20000726	200109290614	200111261855	07/26/00	09/29/01	11/26/01	-0.2	0.2	1.35E-06	1.35E-08	5.36E-08
44	100718	MW	SANTA ANA RIVERVIEW	20000712	200110151825	200111261939	07/12/00	10/15/01	11/26/01	15.7	0.5	1.45E-06	1.45E-08	1.27E-07
45	100788	MW	NEWMARK SIERRA HIGH SCHOOL D8	20001128	200107021821	200109191534	11/28/00	07/02/01	09/19/01	10.7	0.6	1.41E-06	1.41E-08	8.76E-08
46	100591	PS	LYNWOOD 05	20000831	200103180143	200108171539	08/31/00	03/18/01	08/17/01	32.2	1.5	2.48E-06	2.48E-08</td	

	A	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.																
7																	
8		+/-	Ne	+/-	Ar	+/-	Kr	+/-	Xe	+/-							
9	LLNL ID #	(cm³STP/g)	USGS ID #	State ID #	T(C) est	update	Altitude	pressure									
10	100575	1.12E-09	2.05E-07	4.11E-09	5.07E-04	1.01E-05	5.49E-08	1.65E-09	7.99E-09	2.40E-10	340439117173907	01S/04W-22D07 S	17.0	17.0	30	0.996	4.52E-08
11	100576	1.27E-09	2.17E-07	4.35E-09	5.07E-04	1.01E-05	7.26E-08	2.18E-09	1.00E-08	3.00E-10	340707117162707	01S/04W-02D07 S	19.0	19.0	30	0.996	4.49E-08
12	100577	3.38E-09	6.54E-07	1.31E-08	5.11E-04	1.02E-05	1.11E-07	3.32E-09	1.32E-08	3.96E-10	340503117104103	01S/03W-15K03 S	18.8	18.8	30	0.996	4.49E-08
13	100578	2.64E-09	5.88E-07	1.18E-08	5.11E-04	1.02E-05	1.07E-07	3.20E-09	1.31E-08	3.94E-10	340503117104105	01S/03W-15K05 S	17.4	17.4	30	0.996	4.51E-08
14	100579	1.37E-09	2.55E-07	5.10E-09	3.75E-04	7.50E-06	8.41E-08	2.52E-09	1.15E-08	3.44E-10	335112118090402	04S/12W-05H06 S	15.2	15.2	30	0.996	4.55E-08
15	100580	1.51E-09	3.31E-07	6.61E-09	4.50E-04	9.00E-06	9.27E-08	2.78E-09	1.18E-08	3.55E-10	335112118090406	04S/12W-05H10 S	15.7	15.7	30	0.996	4.54E-08
16	100581	1.39E-09	2.61E-07	5.22E-09	3.78E-04	7.56E-06			9.33E-09	2.80E-10	335112118090403	04S/12W-05H07 S	22.8	22.8	30	0.996	4.44E-08
17	100582	1.41E-09	2.41E-07	4.82E-09	3.69E-04	7.38E-06	8.20E-08	2.46E-09	1.12E-08	3.37E-10	335112118090404	04S/12W-05H08 S	15.6	15.6	30	0.996	4.54E-08
18	100583	1.61E-09	3.50E-07	7.00E-09	4.42E-04	8.83E-06	9.59E-08	2.88E-09	1.21E-08	3.64E-10	335517118081302	03S/12W-09J02 S	15.2	15.2	30	0.996	4.55E-08
19	100584	1.25E-09	2.87E-07	5.75E-09	4.08E-04	8.15E-06	8.62E-08	2.59E-09	1.10E-08	3.29E-10	335517118081305	03S/12W-09J05 S	17.5	17.5	30	0.996	4.51E-08
20	100585	1.50E-09	2.71E-07	5.42E-09	3.99E-04	7.98E-06	7.95E-08	2.38E-09	1.15E-08	3.46E-10	335112118090405	04S/12W-05H09 S	15.3	15.3	30	0.996	4.55E-08
21	100586	1.94E-09	4.03E-07	8.07E-09	5.00E-04	9.99E-06	1.02E-07	3.06E-09	1.21E-08	3.64E-10	335517118081306	03S/12W-09J06 S	16.4	16.4	30	0.996	4.53E-08
22	100587	1.84E-09	3.92E-07	7.83E-09	4.74E-04	9.47E-06	8.98E-08	2.69E-09	1.06E-08	3.19E-10	335517118081303	03S/12W-09J03 S	21.3	21.3	30	0.996	4.46E-08
23	100588	1.69E-09	3.39E-07	6.77E-09	4.35E-04	8.71E-06	8.64E-08	2.59E-09	1.12E-08	3.36E-10	335517118081304	03S/12W-09J04 S	17.9	17.9	30	0.996	4.51E-08
24	100589	1.39E-09	2.87E-07	5.74E-09	4.17E-04	8.33E-06	8.71E-08	2.61E-09	1.14E-08	3.41E-10	335642118103705	03S/12W-06B08 S	16.2	16.2	30	0.996	4.53E-08
25	100590	1.21E-09	2.45E-07	4.90E-09	3.69E-04	7.37E-06	5.66E-08	1.70E-09	1.08E-08	3.24E-10	335517118081301	03S/12W-09J01 S	17.0	17.0	30	0.996	4.52E-08
26	100592	1.98E-09	4.11E-07	8.22E-09	4.78E-04	9.56E-06	9.99E-08	3.00E-09	1.24E-08	3.72E-10	335642118113703	03S/12W-06B06 S	15.8	15.8	30	0.996	4.54E-08
27	100596	1.79E-09	3.89E-07	7.77E-09	4.58E-04	9.16E-06	8.43E-08	2.53E-09	1.09E-08	3.28E-10	335642118103702	03S/12W-06B05 S	20.1	20.1	30	0.996	4.47E-08
28	100597	1.90E-09	3.82E-07	7.64E-09	4.60E-04	9.19E-06	9.20E-08	2.76E-09	1.17E-08	3.51E-10	335642118103704	03S/12W-06B07 S	17.3	17.3	30	0.996	4.52E-08
29	100600	2.19E-09	3.33E-07	6.66E-09	4.25E-04	8.51E-06	9.00E-08	2.70E-09	1.15E-08	3.44E-10	335829118065201	02S/12W-26D09 S	16.9	16.9	30	0.996	4.52E-08
30	100601	1.96E-09	3.91E-07	7.81E-09	4.41E-04	8.83E-06	8.19E-08	2.46E-09	1.06E-08	3.19E-10	335829118065204	02S/12W-26D12 S	21.3	21.3	30	0.996	4.46E-08
31	100603	1.54E-09	2.92E-07	5.84E-09	3.76E-04	7.52E-06	7.66E-08	2.30E-09	1.04E-08	3.11E-10	335818118051201	02S/12W-25G03 S	19.7	19.7	30	0.996	4.48E-08
32	100604	1.74E-09	3.45E-07	6.90E-09	4.51E-04	9.03E-06	8.21E-08	2.46E-09	1.14E-08	3.42E-10	335829118065205	02S/12W-26D13 S	17.4	17.4	30	0.996	4.51E-08
33	100605	2.42E-09	3.94E-07	7.89E-09	4.03E-04	8.07E-06	8.61E-08	2.58E-09	1.13E-08	3.40E-10	340541117074401	01S/02W-07Q01 S	18.8	18.8	30	0.996	4.49E-08
34	100606	1.83E-09	3.73E-07	7.46E-09	4.87E-04	9.74E-06	9.67E-08	2.90E-09	1.24E-08	3.71E-10	335829118065202	02S/12W-26D10 S	15.0	15.0	30	0.996	4.55E-08
35	100607	1.74E-09	3.44E-07	6.88E-09	4.43E-04	8.87E-06	9.27E-08	2.78E-09	1.23E-08	3.70E-10	335818118051202	02S/12W-25G04 S	14.5	14.5	30	0.996	4.56E-08
36	100608	1.47E-09	3.10E-07	6.20E-09	4.02E-04	8.03E-06	9.04E-08	2.71E-09	1.14E-08	3.41E-10	335818118051205	02S/12W-25G07 S	16.7	16.7	30	0.996	4.52E-08
37	100609	1.60E-09	3.24E-07	6.48E-09	4.07E-04	8.14E-06	8.93E-08	2.68E-09	1.13E-08	3.39E-10	335818118051204	02S/12W-25G06 S	17.3	17.3	30	0.996	4.52E-08
38	100610	8.49E-09	1.35E-06	2.71E-08	5.34E-04	1.07E-05	1.40E-07	4.19E-09	1.36E-08	4.09E-10	335818118051206	02S/12W-25G08 S	17.0	17.0	30	0.996	4.52E-08
39	100611	3.58E-09															

	A	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.																	
7		excess		excess		Xe equil												
8		Ne	Ne xs	Xe	+-	(alt = 0)	+-	T(C)		Meas	Mean nonrad			⁴ He rad	+-	⁴ He rad	+-	rad cor
9	LLNL ID#	Ne equil	(cm ³ STP/g)	as air	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	calculation	+-	⁴ He/Ne	⁴ He/Ne	+-	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	³ He/ ⁴ He	
10	100575	1.90E-07	1.59E-08	0.0009	1.14E-10	3.81E-11	7.91E-09	2.43E-10	26.3	1.0	0.273	0.240	0.003	6.61E-09	1.14E-09	6.61E-09	1.14E-09	1.43E-06
11	100576	1.86E-07	3.10E-08	0.0017	2.23E-10	7.42E-11	9.82E-09	3.09E-10	19.0	1.0	0.293	0.244	0.005	1.07E-08	1.48E-09	1.07E-08	1.48E-09	1.45E-06
12	100577	1.87E-07	4.67E-07	0.0257	3.35E-09	1.12E-09	9.90E-09	1.19E-09	18.8	3.9	0.258	0.257	0.024	7.45E-10	1.57E-08	7.45E-10	1.57E-08	1.80E-06
13	100578	1.89E-07	3.99E-07	0.0219	2.86E-09	9.54E-10	1.03E-08	1.03E-09	17.4	3.2	0.225	0.255	0.023	-1.78E-08	1.39E-08	0.00E+00	1.39E-08	1.40E-06
14	100579	1.92E-07	6.25E-08	0.0034	4.48E-10	1.49E-10	1.10E-08	3.75E-10	15.2	1.1	0.269	0.243	0.009	6.83E-09	2.56E-09	6.83E-09	2.56E-09	1.35E-06
15	100580	1.92E-07	1.39E-07	0.0076	9.97E-10	3.32E-10	1.09E-08	4.86E-10	15.7	1.4	0.229	0.247	0.015	-6.17E-09	5.20E-09	0.00E+00	5.20E-09	1.72E-06
16	100581	1.81E-07	8.01E-08	0.0044	5.75E-10	1.92E-10	8.78E-09	3.39E-10	22.8	1.3	0.266	0.252	0.009	3.86E-09	2.72E-09	3.86E-09	2.72E-09	1.27E-06
17	100582	1.92E-07	4.91E-08	0.0027	3.52E-10	1.17E-10	1.09E-08	3.57E-10	15.6	1.0	0.293	0.242	0.007	1.24E-08	2.11E-09	1.24E-08	2.11E-09	1.40E-06
18	100583	1.93E-07	1.58E-07	0.0087	1.13E-09	3.77E-10	1.11E-08	5.25E-10	15.2	1.5	0.229	0.248	0.016	-6.51E-09	5.92E-09	0.00E+00	5.92E-09	2.40E-06
19	100584	1.89E-07	9.87E-08	0.0054	7.09E-10	2.36E-10	1.03E-08	4.05E-10	17.5	1.3	0.217	0.247	0.012	-8.59E-09	3.64E-09	0.00E+00	3.64E-09	1.95E-06
20	100585	1.92E-07	7.88E-08	0.0043	5.66E-10	1.89E-10	1.10E-08	3.94E-10	15.3	1.1	0.277	0.244	0.010	9.10E-09	3.12E-09	9.10E-09	3.12E-09	1.39E-06
21	100586	1.90E-07	2.13E-07	0.0117	1.53E-09	5.10E-10	1.06E-08	6.26E-10	16.4	1.9	0.240	0.251	0.018	-4.33E-09	7.70E-09	0.00E+00	7.70E-09	1.94E-06
22	100587	1.83E-07	2.09E-07	0.0115	1.50E-09	4.99E-10	9.18E-09	5.92E-10	21.3	2.2	0.235	0.255	0.016	-8.00E-09	6.74E-09	0.00E+00	6.74E-09	4.48E-06
23	100588	1.88E-07	1.51E-07	0.0083	1.08E-09	3.60E-10	1.02E-08	4.93E-10	17.9	1.6	0.249	0.250	0.015	-3.72E-10	5.34E-09	0.00E+00	5.34E-09	2.87E-06
24	100589	1.91E-07	9.60E-08	0.0053	6.89E-10	2.30E-10	1.07E-08	4.11E-10	16.2	1.2	0.243	0.246	0.012	-9.37E-10	3.65E-09	0.00E+00	3.65E-09	1.36E-06
25	100590	1.89E-07	5.57E-08	0.0031	4.00E-10	1.33E-10	1.04E-08	3.50E-10	17.0	1.1	0.247	0.244	0.008	6.22E-10	2.26E-09	6.22E-10	2.26E-09	1.42E-06
26	100592	1.92E-07	2.20E-07	0.0121	1.58E-09	5.26E-10	1.09E-08	6.44E-10	15.8	1.9	0.241	0.250	0.019	-3.90E-09	8.05E-09	0.00E+00	8.05E-09	4.14E-06
27	100596	1.85E-07	2.04E-07	0.0112	1.46E-09	4.87E-10	9.52E-09	5.88E-10	20.1	2.1	0.230	0.254	0.017	-9.14E-09	6.78E-09	0.00E+00	6.78E-09	2.86E-06
28	100597	1.89E-07	1.93E-07	0.0106	1.39E-09	4.62E-10	1.04E-08	5.80E-10	17.3	1.8	0.249	0.251	0.017	-8.37E-10	6.87E-09	0.00E+00	6.87E-09	2.48E-06
29	100600	1.90E-07	1.43E-07	0.0079	1.03E-09	3.43E-10	1.05E-08	4.86E-10	16.9	1.5	0.329	0.249	0.015	2.67E-08	5.24E-09	2.67E-08	5.24E-09	1.40E-06
30	100601	1.83E-07	2.08E-07	0.0114	1.49E-09	4.97E-10	9.17E-09	5.90E-10	21.3	2.2	0.250	0.255	0.016	-1.81E-09	6.71E-09	0.00E+00	6.71E-09	1.55E-06
31	100603	1.85E-07	1.07E-07	0.0059	7.67E-10	2.56E-10	9.62E-09	4.02E-10	19.7	1.4	0.263	0.250	0.012	3.94E-09	3.73E-09	3.94E-09	3.73E-09	2.11E-06
32	100604	1.89E-07	1.56E-07	0.0086	1.12E-09	3.73E-10	1.03E-08	5.06E-10	17.4	1.6	0.253	0.250	0.015	1.02E-09	5.59E-09	1.02E-09	5.59E-09	1.51E-06
33	100605	1.87E-07	2.08E-07	0.0114	1.49E-09	4.97E-10	9.89E-09	6.02E-10	18.8	2.0	0.307	0.253	0.017	2.13E-08	7.13E-09	2.13E-08	7.13E-09	1.89E-06
34	100606	1.93E-07	1.80E-07	0.0099	1.29E-09	4.31E-10	1.11E-08	5.69E-10	15.0	1.6	0.246	0.248	0.017	-1.05E-09	6.76E-09	0.00E+00	6.76E-09	4.38E-06
35	100607	1.94E-07	1.50E-07	0.0083	1.08E-09	3.59E-10	1.13E-08	5.16E-10	14.5	1.4	0.253	0.247	0.016	2.29E-09	5.74E-09	2.29E-09	5.74E-09	2.34E-06
36	100608	1.90E-07	1.20E-07	0.0066	8.60E-10	2.87E-10	1.05E-08	4.45E-10	16.7	1.4	0.237	0.248	0.013	-3.25E-09	4.42E-09	0.00E+00	4.42E-09	1.46E-06
37	100609	1.89E-07	1.35E-07	0.0074	9.67E-10	3.22E-10	1.04E-08	4.68E-10	17.3	1.5	0.247	0.249	0.014	-5.44E-10	4.87E-09	0.00E+00	4.87E-09	1.56E-06
38	100610	1.90E-07	1.16E-06	0.0640	8.36E-09	2.79E-09	5.29E-09	2.82E-09	39.7	16.8	0.314	0.2						

	A	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI							
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.																					
7		Excess air								Assume no rad ⁴ He												
8		⁴ He	Air derived	³ He from ³ H	(cm ³ STP/g)	(cm ³ STP/g)	+-	Age	+-	³ He from ³ H	(pCi/L)	+-	Age	+-			estimate					
9	LLNL ID#	+-	(cm ³ STP/g)	3He/4He	(cm ³ STP/g)	(cm ³ STP/g)	(yr)	(yr)	(yr)	(pCi/L)	(pCi/L)	(yr)	(yr)	vintage	initial ³ H	% premod						
10	100575	3.95E-08	4.58E-09	1.36E-06	3.03E-15	1.95E-15	7	4	-4.67E-15	7.21E-16	-53	-3	03/24/93	9.6	73%							
11	100576	5.19E-08	8.91E-09	1.37E-06	4.33E-15	2.75E-15	9	5	-8.11E-15	7.94E-16	nc	-3	12/24/90	11.5	71%							
12	100577	1.50E-07	1.34E-07	1.38E-06	7.01E-14	2.53E-14	27	5	6.92E-14	3.03E-15	27	1	02/08/73	105.7	63%							
13	100578	1.26E-07	1.15E-07	1.38E-06	1.25E-15	1.67E-14	1	27	1.25E-15	1.85E-15	1	3	07/27/99	13.2	54%							
14	100579	5.01E-08	1.79E-08	1.37E-06	-1.38E-15	3.10E-15	>50	0	-9.36E-15	8.47E-16	>50	0	na	na	100%							
15	100580	1.06E-07	3.99E-08	1.37E-06	2.56E-14	8.00E-15	25	4	2.56E-14	1.30E-15	25	1	09/12/75	40.3	80%							
16	100581	4.52E-08	2.30E-08	1.37E-06	-6.76E-15	2.97E-15	>50	0	-1.13E-14	8.40E-16	>50	0	na	na	100%							
17	100582	5.75E-08	1.41E-08	1.37E-06	2.09E-15	3.35E-15	>50	0	-1.24E-14	8.43E-16	>50	0	na	na	100%							
18	100583	1.64E-07	4.53E-08	1.37E-06	8.15E-14	1.32E-14	31	3	8.15E-14	1.93E-15	31	1	05/03/69	119.5	76%							
19	100584	1.04E-07	2.83E-08	1.37E-06	3.59E-14	6.48E-15	>50	0	3.59E-14	1.22E-15	>50	0	na	na	100%							
20	100585	5.84E-08	2.26E-08	1.37E-06	1.52E-15	3.86E-15	>50	0	-9.12E-15	9.39E-16	>50	0	na	na	100%							
21	100586	1.39E-07	6.12E-08	1.38E-06	5.23E-14	1.35E-14	17	3	5.23E-14	1.88E-15	17	1	11/09/83	99.5	-38%							
22	100587	3.18E-07	5.99E-08	1.38E-06	2.82E-13	2.92E-14	28	2	2.82E-13	4.12E-15	28	1	07/25/72	425.7	-37%							
23	100588	1.72E-07	4.32E-08	1.37E-06	1.25E-13	1.45E-14	26	2	1.25E-13	2.42E-15	26	1	10/27/74	196.6	12%							
24	100589	6.22E-08	2.76E-08	1.37E-06	-1.04E-15	4.33E-15	>50	0	-1.04E-15	9.44E-16	>50	0	na	na	100%							
25	100590	4.77E-08	1.60E-08	1.37E-06	3.02E-15	2.85E-15	>50	0	2.29E-15	8.50E-16	>50	0	na	na	100%							
26	100592	3.23E-07	6.31E-08	1.38E-06	2.70E-13	3.20E-14	30	2	2.70E-13	4.10E-15	30	1	10/15/70	395.6	2%							
27	100596	2.03E-07	5.85E-08	1.38E-06	1.30E-13	1.82E-14	24	2	1.30E-13	2.56E-15	24	1	03/06/76	207.9	-12%							
28	100597	1.67E-07	5.55E-08	1.38E-06	1.04E-13	1.59E-14	25	2	1.04E-13	2.36E-15	25	1	09/16/75	164.3	17%							
29	100600	8.76E-08	4.11E-08	1.37E-06	2.57E-15	7.26E-15	>50	0	-2.87E-14	1.22E-15	>50	0	na	na	100%							
30	100601	9.36E-08	5.96E-08	1.38E-06	1.56E-14	9.16E-15	10	5	1.56E-14	1.51E-15	10	1	10/14/90	41.6	-2%							
31	100603	9.57E-08	3.07E-08	1.37E-06	5.28E-14	6.99E-15	21	2	4.82E-14	1.55E-15	20	1	04/02/79	89.3	28%							
32	100604	8.52E-08	4.48E-08	1.37E-06	1.08E-14	7.34E-15	8	5	9.56E-15	1.30E-15	8	1	04/04/92	32.0	14%							
33	100605	1.10E-07	5.96E-08	1.37E-06	5.11E-14	1.10E-14	47	4	2.61E-14	1.93E-15	36	1	02/04/54	66.6	99%							
34	100606	3.11E-07	5.17E-08	1.37E-06	2.73E-13	2.85E-14	34	2	2.73E-13	4.01E-15	34	1	02/02/67	389.1	46%							
35	100607	1.43E-07	4.31E-08	1.37E-06	8.04E-14	1.21E-14	21	2	7.77E-14	1.99E-15	21	1	03/19/79	136.6	-10%							
36	100608	7.71E-08	3.44E-08	1.37E-06	5.12E-15	5.67E-15	3	4	5.12E-15	1.07E-15	3	1	08/19/97	30.3	0%							
37	100609	8.45E-08	3.87E-08	1.37E-06	1.42E-14	6.77E-15	9	4	1.42E-14	1.25E-15	9	1	11/12/91	40.6	-6%							
38	100610	1.25E-07	3.34E-07	1.38E-06	1.35E-14	4.39E-14	7	21	-7.30E-14	5.14E-15	nc	-14	09/02/93	44.8	-29%							
39	100611	1.83E-07	1.02E-07	1.38E-06	1.53E-13	2.52E-14	29	2	1.05E-13	3.53E-15	24	0	08/29/71	228.3	36%							
40	100612	9.21E-08	5.02E-08	1.38E-06	3.41E-15	7.90E-15	2	6	3.41E-15	1.23E-15	2	1	12/05/98	28.4	3%							
41	100614	1.29E-07	6.22E-08	1.37E-06	6.78E-14	1.31E-14	25	3	5.81E-14	2.11E-15	23	1	08/11/75	107.0	47%							
42	100716	2.85E-07	2.50E-07	1.37E-06	2.81E-13	7.79E-14	59	5	-1.38E-13	7.29E-15	nc	-1	06/29/41	350.6	99%							
43	100717	3.39E-08	7.63E-09	1.37E-06	8.13E-16	1.76E-15	>50	0	-9.59E-16	7.23E-16	>50	0	na	na	100%							
44	100718	1.82E-07	1.18E-07	1.38E-06	7.90E-15	2.30E-14	8	20	7.90E-15	1.84E-15	8	2	11/12/92	24.2	33%							
45	100788	9.99E-08	5.62E-08	1.38E-06	2.28E-15	8.75E-15	4	15	2.28E-15	1.23E-15	4	2	02/25/97	13.2	57%							
46	100591	1.47E-07	4.21E-08	1.37E-06	9.50E-14	1.23E-14	27	2	9.35E-14	2.11E-15	27	1	03/28/73	150.3	47%							
47	100593	1.50E-07	4.93E-08	1.37E-06	8.81E-14	1.35E-14	25	2	8.81E-14	2.13E-15	25	1	03/30/75	143.5	32%							
48	100594	1.22E-07	2.77E-08	1.37E-06	8.32E-14	8.63E-15	29	2	8.24E-14	1.81E-15	29	1	12/21/71</									

	A	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV
6		Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.												
7														
8														
9	LLNL ID#	Ar equil	Kr equil	Ar pxs	Kr pxs	Ar p	+-	Kr p	+-	normdev Ar	normdev Kr	chisqr	temp	+-
10	100575	3.30E-04	7.49E-08	9.09E-06	1.25E-09	3.39E-04	1.00E-06	7.61E-08	3.12E-10	16.53	-12.68	434.1	bad fit	na
11	100576	3.17E-04	7.11E-08	1.77E-05	2.43E-09	3.34E-04	1.95E-06	7.36E-08	6.08E-10	16.71	-0.44	279.5	bad fit	na
12	100577	3.18E-04	7.16E-08	2.66E-04	3.66E-08	5.85E-04	2.93E-05	1.08E-07	9.15E-09	-2.39	0.25	5.7	18.8	3.9
13	100578	3.27E-04	7.40E-08	2.27E-04	3.13E-08	5.54E-04	2.50E-05	1.05E-07	7.81E-09	-1.59	0.17	2.5	17.4	3.2
14	100579	3.42E-04	7.84E-08	3.56E-05	4.90E-09	3.78E-04	3.92E-06	8.33E-08	1.22E-09	-0.36	0.27	0.2	15.2	1.1
15	100580	3.39E-04	7.75E-08	7.92E-05	1.09E-08	4.18E-04	8.71E-06	8.83E-08	2.72E-09	2.54	1.12	7.7	15.7	1.4
16	100581	2.94E-04	6.50E-08	4.57E-05	6.28E-09	3.40E-04	5.02E-06	7.12E-08	1.57E-09	4.20	-45.39	2077.9	bad fit	na
17	100582	3.40E-04	7.77E-08	2.80E-05	3.85E-09	3.68E-04	3.08E-06	8.15E-08	9.62E-10	0.20	0.19	0.1	15.6	1.0
18	100583	3.42E-04	7.85E-08	8.99E-05	1.24E-08	4.32E-04	9.89E-06	9.08E-08	3.09E-09	0.71	1.21	2.0	15.2	1.5
19	100584	3.26E-04	7.39E-08	5.63E-05	7.74E-09	3.82E-04	6.19E-06	8.16E-08	1.93E-09	2.45	1.42	8.0	17.5	1.3
20	100585	3.42E-04	7.83E-08	4.49E-05	6.18E-09	3.87E-04	4.94E-06	8.44E-08	1.54E-09	1.31	-1.75	4.8	15.3	1.1
21	100586	3.34E-04	7.60E-08	1.21E-04	1.67E-08	4.55E-04	1.34E-05	9.27E-08	4.17E-09	2.67	1.78	10.3	bad fit	na
22	100587	3.03E-04	6.73E-08	1.19E-04	1.63E-08	4.22E-04	1.31E-05	8.36E-08	4.09E-09	3.22	1.25	11.9	bad fit	na
23	100588	3.24E-04	7.32E-08	8.58E-05	1.18E-08	4.10E-04	9.44E-06	8.50E-08	2.95E-09	2.01	0.35	4.2	17.9	1.6
24	100589	3.35E-04	7.65E-08	5.48E-05	7.53E-09	3.90E-04	6.02E-06	8.40E-08	1.88E-09	2.59	0.98	7.6	16.2	1.2
25	100590	3.30E-04	7.48E-08	3.18E-05	4.36E-09	3.61E-04	3.49E-06	7.92E-08	1.09E-09	0.90	-11.17	125.6	bad fit	na
26	100592	3.38E-04	7.73E-08	1.25E-04	1.72E-08	4.64E-04	1.38E-05	9.45E-08	4.30E-09	0.86	1.03	1.8	15.8	1.9
27	100596	3.10E-04	6.93E-08	1.16E-04	1.60E-08	4.26E-04	1.28E-05	8.53E-08	3.99E-09	2.01	-0.21	4.1	20.1	2.1
28	100597	3.28E-04	7.43E-08	1.10E-04	1.51E-08	4.38E-04	1.21E-05	8.95E-08	3.79E-09	1.42	0.53	2.3	17.3	1.8
29	100600	3.31E-04	7.51E-08	8.17E-05	1.12E-08	4.12E-04	8.99E-06	8.63E-08	2.81E-09	1.05	0.95	2.0	16.9	1.5
30	100601	3.03E-04	6.73E-08	1.18E-04	1.63E-08	4.21E-04	1.30E-05	8.35E-08	4.07E-09	1.29	-0.33	1.8	21.3	2.2
31	100603	3.12E-04	7.00E-08	6.09E-05	8.37E-09	3.73E-04	6.70E-06	7.83E-08	2.09E-09	0.29	-0.55	0.4	19.7	1.4
32	100604	3.27E-04	7.42E-08	8.89E-05	1.22E-08	4.16E-04	9.78E-06	8.64E-08	3.06E-09	2.63	-1.10	8.2	17.4	1.6
33	100605	3.18E-04	7.16E-08	1.18E-04	1.63E-08	4.36E-04	1.30E-05	8.78E-08	4.07E-09	-2.16	-0.36	4.8	18.8	2.0
34	100606	3.44E-04	7.88E-08	1.03E-04	1.41E-08	4.46E-04	1.13E-05	9.29E-08	3.53E-09	2.71	0.81	8.0	15.0	1.6
35	100607	3.47E-04	7.99E-08	8.56E-05	1.18E-08	4.33E-04	9.42E-06	9.16E-08	2.94E-09	0.81	0.26	0.7	14.5	1.4
36	100608	3.32E-04	7.54E-08	6.83E-05	9.39E-09	4.00E-04	7.51E-06	8.48E-08	2.35E-09	0.14	1.55	2.4	16.7	1.4
37	100609	3.28E-04	7.43E-08	7.68E-05	1.06E-08	4.05E-04	8.45E-06	8.49E-08	2.64E-09	0.20	1.16	1.4	17.3	1.5
38	100610	3.30E-04	7.49E-08	6.64E-04	9.13E-08	9.94E-04	7.30E-05	1.66E-07	2.28E-08	-6.22	-1.14	40.0	bad fit	na
39	100611	3.49E-04	8.04E-08	2.02E-04	2.78E-08	5.51E-04	2.22E-05	1.08E-07	6.95E-09	0.32	0.62	0.5	14.3	2.6
40	100612	3.33E-04	7.58E-08	9.97E-05	1.37E-08	4.33E-04	1.10E-05	8.95E-08	3.43E-09	2.17	-0.35	4.8	16.5	1.7
41	100614	3.21E-04	7.25E-08	1.24E-04	1.70E-08	4.45E-04	1.36E-05	8.94E-08	4.25E-09	0.83	-0.04	0.7	18.3	2.0
42	100716	3.30E-04	7.49E-08	4.96E-04	6.81E-08	8.25E-04	5.45E-05	1.43E-07	1.70E-08	-5.52	-1.01	31.5	bad fit	na
43	100717	3.26E-04	7.37E-08	1.52E-05	2.08E-09	3.41E-04	1.67E-06	7.58E-08	5.21E-10	-9.39	0.51	88.5	bad fit	na
44	100718	4.20E-04	1.02E-07	2.33E-04	3.21E-08	6.54E-04	2.57E-05	1.34E-07	8.02E-09	-5.11	2.32	31.5	bad fit	na
45	100788	3.38E-04	7.72E-08	1.12E-04	1.53E-08	4.49E-04	1.23E-05	9.25E-08	3.83E-09	7.56	1.68	60.0	bad fit	na
46	100591	3.30E-04	7.49E-08	8.35E-05	1.15E-08	4.13E-04	9.19E-06	8.63E-08	2.87E-09	2.42	1.62	no Xe	no Xe	na
47	100593	3.30E-04	7.49E-08	9.79E-05	1.35E-08	4.28E-04	1.08E-05	8.83E-08	3.36E-09	1.78	-0.26	no Xe	no Xe	na
48	100594	3.30E-04	7.49E-08	5.51E-05	7.57E-09	3.85E-04	6.06E-06	8.24E-08	1.89E-09	1.72	2.68	no Xe	no Xe	na
49	100595	2.89E-04	6.35E-08	9.43E-05	1.30E-08	3.83E-04	1.04E-05	7.65E-08	3.24E-09	-2.4				

6	A	B	C	D	E	F	G	H	I	J	K	L	M	N
7			Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.											
8		Well	Sample	Dissolved gas	Tritium	Collection	Dissolved gas	Tritium	At collection	At dissolved				
9	LLNL ID#	type	Well name	collection date	analysis date	analysis date	date	analysis date	time	gas meas time				
67	100628	PS	BP CABALLERO	20001011	200104101951	200108301330	10/11/00	04/10/01	08/30/01	0.5	0.7	1.25E-06	1.25E-08	6.21E-08
68	100629	PS	LB CITIZENS WELL 7a	20000928	200104041840	200109181729	09/28/00	04/04/01	09/18/01	0.2	0.4	6.99E-07	6.99E-09	1.10E-07
69	100630	PS	DOMINGUEZ 90	20001010	200104101821	200110091619	10/10/00	04/10/01	10/09/01	0.0	0.3	1.19E-06	1.19E-08	6.84E-08
70	100631	PS	LB ANNEX 201	20000928	200104042142	200109251547	09/28/00	04/04/01	09/25/01	0.2	0.3	9.93E-07	9.93E-09	7.07E-08
71	100632	PS	DOMINGUEZ 79	20001012	200103310110	200108281749	10/12/00	03/31/01	08/28/01	0.0	0.6	1.09E-06	1.09E-08	7.43E-08
72	100633	PS	BP KNOTT AVENUE	20001011	200103281906	200109181856	10/11/00	03/28/01	09/18/01	0.1	0.3	1.23E-06	1.23E-08	5.98E-08
73	100634	PS	SOUTH GATE 19	20001011	200110260243	200109181812	10/11/00	10/26/01	09/18/01	31.7	1.4	2.33E-06	2.33E-08	8.71E-08
74	100635	PS	SOUTH GATE 13	20001011	200110252306	200109181645	10/11/00	10/25/01	09/18/01	36.7	1.6	2.56E-06	2.56E-08	8.82E-08
75	100636	PS	BP BOISSERANC	20001011	200104110023	200109171843	10/11/00	04/11/01	09/17/01	0.2	0.3	1.30E-06	1.30E-08	6.18E-08
76	100637	PS	N. LONG BEACH 04	20000928	200104042314	200109191617	09/28/00	04/04/01	09/19/01	-0.1	0.2	5.39E-07	5.39E-09	1.68E-07
77	100638	PS	DOMINGUEZ 98	20001010	200104131938	200109181601	10/10/00	04/13/01	09/18/01	0.5	0.3	1.36E-06	1.36E-08	1.03E-07
78	100639	PS	DOMINGUEZ 15	20001010	200103171941	200109191701	10/10/00	03/17/01	09/19/01	0.2	0.2	1.40E-06	1.40E-08	4.55E-08
79	100640	PS	SANTA ANA 36	20000811	200110161540	200110291439	08/11/00	10/16/01	10/29/01	11.2	0.5	1.95E-06	1.95E-08	8.66E-08
80	100641	PS	GARDEN GROVE 20	20000810	200104131807	200108162145	08/10/00	04/13/01	08/16/01	2.2	1.1	1.56E-06	1.56E-08	7.57E-08
81	100642	PS	ANAHEIM 33	20000918	200109070659	200110081912	09/18/00	09/07/01	10/08/01	18.7	0.9	1.54E-06	1.54E-08	1.23E-07
82	100643	PS	WESTMINSTER 99	20000808	200104131636	200110101932	08/08/00	04/13/01	10/10/01	0.8	0.4	1.41E-06	1.41E-08	6.55E-08
83	100644	PS	GARDEN GROVE 23	20000810	200104140010	200108171747	08/10/00	04/14/01	08/17/01	30.9	1.5	2.62E-06	2.62E-08	9.55E-08
84	100645	PS	EMA-AH2	20000920	200106080349	200109251842	09/20/00	06/08/01	09/25/01	17.1	0.6	1.49E-06	1.49E-08	1.40E-07
85	100646	PS	ANAHEIM 34	20000919	200106072224	200108071709	09/19/00	06/07/01	08/07/01	18.7	0.9	1.63E-06	1.63E-08	8.02E-08
86	100647	PS	ANAHEIM 19	20000918	200106080201	200108282047	09/18/00	06/08/01	08/28/01	26.4	1.4	2.28E-06	2.28E-08	8.72E-08
87	100648	PS	WESTMINSTER 04	20000809	200104140140	200108171911	08/09/00	04/14/01	08/17/01	0.0	1.6	1.41E-06	1.41E-08	7.17E-08
88	100649	PS	ANAHEIM 36	20000919	200106072036	200107202223	09/19/00	06/07/01	07/20/01	25.6	1.3	2.02E-06	2.02E-08	8.99E-08
89	100650	PS	GARDEN GROVE 26	20000809	200104132239	200109181350	08/09/00	04/13/01	09/18/01	14.7	0.8	2.11E-06	2.11E-08	8.42E-08
90	100651	PS	EOCW-E	20000825	200106081145	200108301836	08/25/00	06/08/01	08/30/01	14.0	1.1	1.76E-06	1.76E-08	2.01E-07
91	100652	PS	TMIX-O	20000823	200106080954	200108312220	08/23/00	06/08/01	08/31/01	23.2	0.8	1.43E-06	1.43E-08	6.15E-08
92	100653	PS	NB-DOLS	20000821	200103282036	200108282002	08/21/00	03/28/01	08/28/01	82.6	3.4	1.87E-06	1.87E-08	9.55E-08
93	100654	PS	SCWC-SORG	20000824	200106071848	200108022135	08/24/00	06/07/01	08/02/01	4.1	0.3	1.58E-06	1.58E-08	7.44E-08
94	100655	PS	SANTA ANA 18	20000824	200104180143	200109181434	08/24/00	04/18/01	09/18/01	18.6	1.0	1.64E-06	1.64E-08	3.39E-07
95	100656	PS	WESTMINSTER SC4	20000808	200104171810	200110092125	08/08/00	04/17/01	10/09/01	2.5	0.4	1.53E-06	1.53E-08	7.64E-08
96	100657	PS	ORANGE 03	20000822	200103152127	200105141603	08/22/00	03/15/01	05/14/01	18.2	0.8	1.51E-06	1.51E-08	8.84E-08
97	100658	PS	GARDEN GROVE 28	20000822	200103302339	200108281915	08/22/00	03/30/01	08/28/01	21.1	1.3	1.52E-06	1.52E-08	2.11E-07
98	100659	PS	WESTMINSTER 03	20000807	200104171639	200108171829	08/07/00	04/17/01	08/17/01	7.3	0.8	1.72E-06	1.72E-08	8.44E-08
99	100660	PS	ANAHEIM 12	20001010	200104172111	200109171548	10/10/00	04/17/01	09/17/01	20.9	0.9	2.33E-06	2.33E-08	8.94E-08
100	100661	PS	ANAHEIM 43	20001011	200104181336	200108172036	10/11/00	04/18/01	08/17/01	19.3	1.1	1.61E-06	1.61E-08	7.49E-08
101	100662	PS	ANAHEIM 39	20001010	200105080933	20011261809	10/10/00	05/08/01	11/26/01	17.8	0.6	2.26E-06	2.26E-08	7.81E-08
102	100663	PS	SANTA ANA 37	20001012	200110262302	200108301414	10/12/00	10/26/01	08/30/01	0.1	0.7	1.30E-06	1.30E-08	5.97E-08
103	100664	PS	ANAHEIM 40	20001010	200105090415	200109191956	10/10/00	05/09/01	09/19/01	58.0	2.3	3.56E-06	3.56E-08	8.30E-08
104	100665	PS	PICO RIVERA W2	20001011										

	A	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.																
7		+/-	Ne	+/-	Ar	+/-	Kr	+/-	Xe	+/-							
8	LLNL ID#	(cm³STP/g)	USGS ID #	State ID #	T(C) est	update	Altitude	pressure									
9																	
67	100628	1.24E-09	2.36E-07	4.72E-09	3.60E-04	7.20E-06	8.15E-09	2.45E-09	1.17E-08	3.50E-10	335154118011301	03S/11W-34L01 S	14.2	14.2	30	0.996	4.57E-08
68	100629	2.20E-09	2.14E-07	4.29E-09	3.56E-04	7.11E-06	7.89E-08	2.37E-09	6.92E-09	2.08E-10	334837118090301	04S/12W-21M07 S	17.0	17.0	30	0.996	4.52E-08
69	100630	1.37E-09	2.42E-07	4.85E-09	3.66E-04	7.32E-06	8.35E-08	2.51E-09	1.22E-08	3.65E-10	335152118130201	03S/13W-35F15 S	13.0	13.0	30	0.996	4.59E-08
70	100631	1.41E-09	2.10E-07	4.20E-09	3.45E-04	6.89E-06	7.99E-08	2.40E-09	8.26E-09	2.48E-10	334836118061201	04S/12W-23K03 S	17.0	17.0	30	0.996	4.52E-08
71	100632	7.43E-10	2.23E-07	4.45E-09	3.51E-04	7.02E-06	7.59E-08	1.52E-09			334902118155601	04S/13W-20C01 S	17.0	17.0	30	0.996	4.52E-08
72	100633	1.79E-09	2.27E-07	4.55E-09	3.53E-04	7.07E-06	7.52E-08	1.50E-09			335158118004201	03S/11W-34H03 S	17.0	17.0	30	0.996	4.52E-08
73	100634	1.74E-09	3.61E-07	7.23E-09	4.49E-04	8.98E-06	9.53E-08	2.86E-09	1.20E-08	3.59E-10	335644118110301	03S/12W-06D04 S	16.0	16.0	30	0.996	4.54E-08
74	100635	1.76E-09	3.69E-07	7.38E-09	4.53E-04	9.06E-06	9.44E-08	2.83E-09	1.20E-08	3.59E-10	335637118110501	03S/12W-06D01 S	16.2	16.2	30	0.996	4.53E-08
75	100636	1.24E-09	2.47E-07	4.93E-09	3.64E-04	7.28E-06	8.22E-08	2.47E-09	1.10E-08	3.31E-10	335110117585701	04S/11W-01K01 S	16.4	16.4	30	0.996	4.53E-08
76	100637	3.35E-09	2.32E-07	4.63E-09	3.74E-04	7.48E-06	8.56E-08	2.57E-09	8.83E-09	2.65E-10	335105118012802	04S/12W-06K01 S	23.9	23.9	30	0.996	4.42E-08
77	100638	2.06E-09	2.15E-07	4.30E-09	3.47E-04	6.93E-06	7.63E-08	2.29E-09	1.01E-08	3.03E-10	334955118100201	04S/13W-15A14 S	18.7	18.7	30	0.996	4.49E-08
78	100639	4.55E-10	1.80E-07	3.60E-09	2.97E-04	5.94E-06	6.47E-08	1.29E-09			334950118132501	04S/13W-15A11 S	17.0	17.0	30	0.996	4.52E-08
79	100640	1.73E-09	3.54E-07	7.08E-09	4.25E-04	8.50E-06	8.85E-08	2.65E-09	1.17E-08	3.50E-10	334609117530401	05S/10W-01E03 S	16.7	16.7	30	0.996	4.52E-08
80	100641	1.51E-09	3.00E-07	6.01E-09	4.15E-04	8.30E-06	8.47E-08	2.54E-09	1.16E-08	3.48E-10	334601117582401	05S/11W-01H02 S	15.7	15.7	30	0.996	4.54E-08
81	100642	2.46E-09	4.82E-07	9.64E-09	4.83E-04	9.65E-06	9.19E-08	2.76E-09	1.14E-08	3.43E-10	334753117525901	04S/10W-25F01 S	20.7	20.7	30	0.996	4.46E-08
82	100643	1.31E-09	2.57E-07	5.14E-09	3.80E-04	7.60E-06	8.02E-08	2.41E-09	1.17E-08	3.51E-10	334500118003001	05S/11W-10J04 S	14.5	14.5	30	0.996	4.56E-08
83	100644	1.91E-09	3.71E-07	7.41E-09	4.50E-04	9.01E-06	8.37E-08	2.51E-09	1.16E-08	3.49E-10	334704117561101	04S/10W-33F02 S	17.2	17.2	30	0.996	4.52E-08
84	100645	2.79E-09	5.59E-07	1.12E-08	5.43E-04	1.09E-05	1.12E-07	3.37E-09	1.13E-08	3.38E-10	335118117481401	04S/09W-03H02 S	23.6	23.6	30	0.996	4.43E-08
85	100646	1.60E-09	3.32E-07	6.64E-09	4.21E-04	8.42E-06	8.39E-08	2.52E-09	1.12E-08	3.35E-10	334949117544301	04S/10W-15B05 S	17.9	17.9	30	0.996	4.51E-08
86	100647	1.74E-09	3.68E-07	7.35E-09	4.48E-04	8.96E-06	9.63E-08	2.89E-09	1.18E-08	3.54E-10	334903117535201	04S/10W-23B02 S	16.7	16.7	30	0.996	4.53E-08
87	100648	1.43E-09	2.94E-07	5.87E-09	4.05E-04	8.11E-06	8.11E-08	2.43E-09	1.11E-08	3.33E-10	334418117573301	05S/10W-18G01 S	17.1	17.1	30	0.996	4.52E-08
88	100649	1.80E-09	3.75E-07	7.51E-09	4.40E-04	8.81E-06	8.61E-08	2.58E-09	1.14E-08	3.43E-10	334833117555501	04S/10W-33A04 S	18.0	18.0	30	0.996	4.50E-08
89	100650	1.68E-09	3.35E-07	6.71E-09	4.34E-04	8.69E-06	8.62E-08	2.59E-09	1.17E-08	3.50E-10	334603117544901	05S/10W-03F01 S	16.4	16.4	30	0.996	4.53E-08
90	100651	4.01E-09	6.98E-07	1.40E-08	5.01E-04	1.00E-05	1.03E-07	3.09E-09	1.26E-08	3.79E-10	334722117491901	04S/09W-28R02 S	22.1	22.1	30	0.996	4.44E-08
91	100652	1.23E-09	2.59E-07	5.18E-09	3.61E-04	7.21E-06	7.34E-08	2.20E-09	1.03E-08	3.08E-10	334859117520501	04S/09W-19D05 S	19.2	19.2	30	0.996	4.49E-08
92	100653	2.87E-09	3.66E-07	7.31E-09	4.61E-04	9.22E-06	9.12E-08	1.82E-09			334231117573101	05S/10W-30K05 S	17.0	17.0	30	0.996	4.52E-08
93	100654	1.49E-09	3.16E-07	6.31E-09	4.21E-04	8.42E-06	8.96E-08	2.69E-09	1.14E-08	3.41E-10	334744117594601	04S/11W-26J02 S	16.9	16.9	30	0.996	4.52E-08
94	100655	6.79E-09	1.17E-06	2.34E-08	6.88E-04	1.38E-05	1.25E-07	3.76E-09	1.43E-08	4.30E-10	334609117525701	05S/10W-01E02 S	17.0	17.0	30	0.996	4.52E-08
95	100656	1.53E-09	3.12E-07	6.23E-09	4.26E-04	8.51E-06	8.64E-08	2.59E-09	1.18E-08	3.55E-10	334613118005901	05S/11W-03C01 S	15.3	15.3	30	0.996	4.55E-08
96	100657	8.84E-10	3.56E-07	7.12E-09	4.27E-04	8.54E-06	8.68E-08	1.74E-09			334731117540401	04S/10W-26N01 S					

	A	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.																	
7		excess		excess		Xe equil												
8		Ne	Ne xs	Xe	+-	(alt = 0)	+-	T(C)		Meas	Mean nonrad			⁴He rad	+-	⁴He rad	+-	rad cor
9	LLNL ID#	Ne equil	(cm³STP/g)	as air	(cm³STP/g)	(cm³STP/g)	(cm³STP/g)	(cm³STP/g)	calculation	+-	⁴He/Ne	⁴He/Ne	+-	(cm³STP/g)	(cm³STP/g)	(cm³STP/g)	(cm³STP/g)	³He/⁴He
67	100628	1.94E-07	4.16E-08	0.0023	2.98E-10	9.95E-11	1.14E-08	3.64E-10	14.2	1.0	0.263	0.240	0.006	5.55E-09	1.91E-09	5.55E-09	1.91E-09	1.36E-06
68	100629	1.90E-07	2.49E-08	0.0014	1.79E-10	5.96E-11	6.77E-09	2.16E-10	31.6	1.1	0.514	0.241	0.004	5.84E-08	1.78E-09	5.84E-08	1.78E-09	1.26E-06
69	100630	1.96E-07	4.60E-08	0.0025	3.30E-10	1.10E-10	1.19E-08	3.81E-10	13.0	1.0	0.282	0.239	0.007	1.06E-08	2.10E-09	1.06E-08	2.10E-09	1.37E-06
70	100631	1.90E-07	2.04E-08	0.0011	1.46E-10	4.87E-11	8.14E-09	2.52E-10	25.3	1.1	0.337	0.241	0.003	2.02E-08	1.29E-09	2.02E-08	1.29E-09	1.31E-06
71	100632	1.90E-07	3.30E-08	0.0018	2.37E-10	7.90E-11	-2.38E-10	7.90E-11	no Xe	no Xe	0.334	0.242	0.005	2.04E-08	1.62E-09	2.04E-08	1.62E-09	1.42E-06
72	100633	1.90E-07	3.80E-08	0.0021	2.73E-10	9.08E-11	-2.74E-10	9.08E-11	no Xe	no Xe	0.263	0.243	0.006	4.58E-09	1.71E-09	4.58E-09	1.71E-09	1.32E-06
73	100634	1.91E-07	1.70E-07	0.0094	1.22E-09	4.07E-10	1.08E-08	5.43E-10	16.0	1.6	0.241	0.249	0.017	-2.89E-09	6.27E-09	0.00E+00	6.27E-09	2.33E-06
74	100635	1.91E-07	1.78E-07	0.0098	1.28E-09	4.26E-10	1.07E-08	5.57E-10	16.2	1.7	0.239	0.250	0.017	-3.91E-09	6.51E-09	0.00E+00	6.51E-09	2.56E-06
75	100636	1.91E-07	5.61E-08	0.0031	4.03E-10	1.34E-10	1.07E-08	3.57E-10	16.4	1.1	0.250	0.243	0.008	1.73E-09	2.30E-09	1.73E-09	2.30E-09	1.33E-06
76	100637	1.79E-07	5.23E-08	0.0029	3.75E-10	1.25E-10	8.49E-09	2.93E-10	23.9	1.2	0.723	0.251	0.007	1.09E-07	2.90E-09	1.09E-07	2.90E-09	1.18E-06
77	100638	1.87E-07	2.81E-08	0.0015	2.02E-10	6.72E-11	9.92E-09	3.10E-10	18.7	1.0	0.478	0.244	0.004	5.05E-08	1.72E-09	5.05E-08	1.72E-09	2.48E-06
78	100639	1.90E-07	-9.42E-09	-0.0005	-6.76E-11	-2.25E-11	6.79E-11	2.25E-11	no Xe	no Xe	0.253	0.237	0.002	2.77E-09	9.15E-10	2.77E-09	9.15E-10	1.47E-06
79	100640	1.90E-07	1.64E-07	0.0090	1.18E-09	3.93E-10	1.05E-08	5.26E-10	16.7	1.6	0.245	0.250	0.016	-1.76E-09	5.95E-09	0.00E+00	5.95E-09	1.95E-06
80	100641	1.92E-07	1.09E-07	0.0060	7.81E-10	2.60E-10	1.09E-08	4.35E-10	15.7	1.3	0.252	0.246	0.013	1.81E-09	4.13E-09	1.81E-09	4.13E-09	1.59E-06
81	100642	1.84E-07	2.98E-07	0.0164	2.14E-09	7.13E-10	9.33E-09	7.91E-10	20.7	2.8	0.255	0.257	0.019	-5.59E-10	9.66E-09	0.00E+00	9.66E-09	1.54E-06
82	100643	1.94E-07	6.35E-08	0.0035	4.56E-10	1.52E-10	1.13E-08	3.83E-10	14.5	1.1	0.255	0.242	0.009	3.27E-09	2.63E-09	3.27E-09	2.63E-09	1.47E-06
83	100644	1.89E-07	1.82E-07	0.0100	1.30E-09	4.34E-10	1.04E-08	5.57E-10	17.2	1.7	0.258	0.251	0.017	2.64E-09	6.48E-09	2.64E-09	6.48E-09	2.69E-06
84	100645	1.80E-07	3.79E-07	0.0209	2.72E-09	9.07E-10	8.58E-09	9.68E-10	23.6	3.8	0.250	0.260	0.020	-5.60E-09	1.14E-08	0.00E+00	1.14E-08	1.49E-06
85	100646	1.88E-07	1.44E-07	0.0079	1.03E-09	3.44E-10	1.02E-08	4.80E-10	17.9	1.5	0.242	0.250	0.015	-2.74E-09	5.12E-09	0.00E+00	5.12E-09	1.63E-06
86	100647	1.90E-07	1.78E-07	0.0098	1.27E-09	4.25E-10	1.06E-08	5.53E-10	16.7	1.7	0.237	0.250	0.017	-4.69E-09	6.42E-09	0.00E+00	6.42E-09	2.28E-06
87	100648	1.89E-07	1.04E-07	0.0057	7.50E-10	2.50E-10	1.04E-08	4.17E-10	17.1	1.3	0.244	0.247	0.012	-9.39E-10	3.86E-09	0.00E+00	3.86E-09	1.41E-06
88	100649	1.88E-07	1.87E-07	0.0103	1.34E-09	4.48E-10	1.01E-08	5.65E-10	18.0	1.8	0.240	0.252	0.017	-4.49E-09	6.56E-09	0.00E+00	6.56E-09	2.02E-06
89	100650	1.91E-07	1.45E-07	0.0080	1.04E-09	3.46E-10	1.07E-08	4.92E-10	16.4	1.5	0.251	0.248	0.015	8.98E-10	5.32E-09	8.98E-10	5.32E-09	2.13E-06
90	100651	1.82E-07	5.16E-07	0.0284	3.71E-09	1.24E-09	8.95E-09	1.29E-09	22.1	4.9	0.287	0.260	0.022	1.89E-08	1.60E-08	1.89E-08	1.60E-08	1.92E-06
91	100652	1.86E-07	7.31E-08	0.0040	5.25E-10	1.75E-10	9.78E-09	3.54E-10	19.2	1.2	0.237	0.248	0.009	-2.71E-09	2.71E-09	0.00E+00	2.71E-09	1.43E-06
92	100653	1.90E-07	1.76E-07	0.0097	1.26E-09	4.21E-10	-1.27E-09	4.21E-10	no Xe	no Xe	0.261	0.250	0.017	4.02E-09	6.32E-09	4.02E-09	6.32E-09	1.95E-06
93	100654	1.90E-07	1.26E-07	0.0069	9.04E-10	3.01E-10	1.05E-08	4.55E-10	16.9	1.4	0.236	0.248	0.014	-3.89E-09	4.62E-09	0.00E+00	4.62E-09	1.58E-06
94	100655	1.90E-07	9.81E-07	0.0540	7.04E-09	2.35E-09	7.33E-09	2.39E-09	29.0	11.1	0.290	0.259	0.029	3.64E-08	3.43E-08	3.64E-08	3.43E-08	1.81E-06
95	100656	1.92E-07	1.19E-07	0.0066	8.56E-10	2.85E-10	1.10E-08	4.55E-10	15.3	1.3	0.245	0.246	0.014	-2.55E-10	4.54E-09	0.00E+00	4.5	

	A	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.														
7		Excess air													
8		⁴ He	Air derived	³ He from ³ H	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	Age	(yr)	(yr)	³ He from ³ H	(pCi/L)	(pCi/L)	Age	(yr)
9	LLNL ID#	+-	(cm ³ STP/g)	3He/4He	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	+-	(yr)	(yr)	vintage	initial ³ H	% premod	+-	estimate
67	100628	4.29E-08	1.19E-08	1.37E-06	-5.58E-16	2.42E-15	>50	0	-7.04E-15	7.79E-16	>50	0	na	na	100%
68	100629	2.27E-07	7.15E-09	1.36E-06	-5.28E-15	1.17E-14	>50	0	-7.33E-14	7.70E-16	>50	0	na	na	100%
69	100630	5.32E-08	1.32E-08	1.37E-06	2.82E-16	3.08E-15	>50	0	-1.20E-14	8.15E-16	>50	0	na	na	100%
70	100631	8.35E-08	5.85E-09	1.36E-06	-2.81E-15	4.22E-15	>50	0	-2.63E-14	7.02E-16	>50	0	na	na	100%
71	100632	8.17E-08	9.48E-09	1.37E-06	3.18E-15	4.40E-15	>50	0	-2.06E-14	8.09E-16	>50	0	na	na	100%
72	100633	3.84E-08	1.09E-08	1.37E-06	-2.78E-15	2.12E-15	>50	0	-8.13E-15	7.36E-16	>50	0	na	na	100%
73	100634	1.55E-07	4.89E-08	1.37E-06	8.16E-14	1.35E-14	25	2	8.16E-14	2.03E-15	25	1	09/30/75	129.4	36%
74	100635	1.76E-07	5.12E-08	1.38E-06	1.03E-13	1.56E-14	26	2	1.03E-13	2.26E-15	26	1	07/17/74	160.3	33%
75	100636	4.46E-08	1.61E-08	1.37E-06	-2.24E-15	2.67E-15	>50	0	-4.26E-15	8.03E-16	>50	0	na	na	100%
76	100637	3.77E-07	1.50E-08	1.37E-06	-1.09E-14	2.19E-14	>50	0	-1.38E-13	9.04E-16	>50	0	na	na	100%
77	100638	1.98E-07	8.06E-09	1.36E-06	5.81E-14	1.04E-14	>50	0	-6.67E-16	1.40E-15	>50	0	na	na	100%
78	100639	3.23E-08	-2.70E-09	1.36E-06	4.72E-15	1.38E-15	>50	0	1.50E-15	6.35E-16	>50	0	na	na	100%
79	100640	1.22E-07	4.71E-08	1.37E-06	4.94E-14	1.05E-14	33	3	4.94E-14	1.69E-15	33	1	12/02/67	70.2	89%
80	100641	7.78E-08	3.12E-08	1.37E-06	1.62E-14	5.75E-15	41	10	1.41E-14	1.18E-15	39	7	02/15/59	22.3	99%
81	100642	1.06E-07	8.56E-08	1.38E-06	1.89E-14	1.31E-14	14	7	1.89E-14	1.89E-15	14	1	10/23/86	40.9	25%
82	100643	5.43E-08	1.82E-08	1.37E-06	6.54E-15	3.38E-15	>50	0	2.72E-15	9.24E-16	>50	0	na	na	100%
83	100644	1.71E-07	5.21E-08	1.37E-06	1.22E-13	1.59E-14	31	2	1.19E-13	2.51E-15	31	1	02/23/69	181.2	65%
84	100645	1.06E-07	1.09E-07	1.38E-06	1.51E-14	1.49E-14	13	9	1.51E-14	2.08E-15	13	1	11/11/87	35.2	30%
85	100646	9.24E-08	4.13E-08	1.37E-06	1.97E-14	7.41E-15	15	4	1.97E-14	1.30E-15	15	1	02/27/86	42.4	27%
86	100647	1.55E-07	5.10E-08	1.38E-06	7.76E-14	1.35E-14	27	3	7.76E-14	1.98E-15	27	1	07/06/73	121.8	56%
87	100648	6.68E-08	3.00E-08	1.37E-06	2.88E-15	4.79E-15	>50	0	2.88E-15	1.01E-15	>50	0	na	na	100%
88	100649	1.35E-07	5.38E-08	1.38E-06	5.73E-14	1.21E-14	23	3	5.73E-14	1.82E-15	23	1	04/04/77	95.8	41%
89	100650	1.24E-07	4.16E-08	1.37E-06	6.27E-14	1.03E-14	33	3	6.16E-14	1.78E-15	32	1	11/22/67	92.2	85%
90	100651	1.40E-07	1.48E-07	1.38E-06	9.83E-14	2.55E-14	40	4	7.60E-14	3.53E-15	36	1	04/30/60	134.9	93%
91	100652	5.59E-08	2.10E-08	1.37E-06	2.69E-15	3.43E-15	2	3	2.69E-15	8.77E-16	2	1	12/14/98	25.5	13%
92	100653	1.18E-07	5.06E-08	1.37E-06	5.03E-14	1.08E-14	10	2	4.56E-14	1.79E-15	9	0	11/26/90	142.7	-255%
93	100654	8.71E-08	3.62E-08	1.37E-06	1.53E-14	6.48E-15	31	6	1.53E-14	1.18E-15	31	2	12/24/69	22.8	95%
94	100655	1.65E-07	2.82E-07	1.38E-06	1.30E-13	5.01E-14	40	6	8.71E-14	5.56E-15	34	1	03/12/60	180.0	91%
95	100656	8.06E-08	3.42E-08	1.37E-06	1.23E-14	6.16E-15	35	8	1.23E-14	1.17E-15	35	3	11/06/65	17.7	98%
96	100657	8.98E-08	4.79E-08	1.37E-06	1.11E-14	7.94E-15	10	6	1.11E-14	1.33E-15	10	1	11/04/90	31.5	22%
97	100658	1.37E-07	1.59E-07	1.38E-06	5.40E-14	2.62E-14	25	7	2.98E-14	3.22E-15	18	1	04/07/75	87.8	58%
98	100659	1.04E-07	4.28E-08	1.37E-06	2.91E-14	8.74E-15	32	5	2.91E-14	1.45E-15	32	2	12/04/68	43.2	92%
99	100660	1.59E-07	5.05E-08	1.37E-06	8.48E-14	1.42E-14	32	3	8.48E-14	2.08E-15	32	1	09/09/68	126.8	78%
100	100661	8.10E-08	3.44E-08	1.37E-06	1.72E-14	6.07E-15	13	3	1.72E-14	1.21E-15	13	1	08/19/87	40.4	21%
101	100662	1.22E-07	3.70E-08	1.37E-06	6.85E-14	9.54E-15	31	2	6.85E-14	1.76E-15	31	1	07/05/69	103.0	79%
102	100663	4.02E-08	1.22E-08	1.37E-06	8.68E-17	2.26E-15	>50	0	-3.90E-15	7.77E-16	>50	0	na	na	100%
103	100664	2.21E-07	4.17E-08	1.37E-06	1.80E-13	1.84E-14	28	2	1.80E-13	2.96E-15	28	1	08/25/72	281.5	10%
104	100665	7.22E-08	1.95E-08	1.37E-06	2.45E-14	4.29E-15	13	2	2.45E-14	1.07E-15	13	1	05/06/87	53.7	-2%
105	100666	1.30E-07	1.37E-07	1.38E-06	8.87E-14	2.22E-14	31	4	3.80E-14	3.33E-15	20	0	09/26/69	134.1	72%
106	100667	6.51E-08	2.54E-08	1.37E-06	1.70E-15	4.20E-15									

	A	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV
6		Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.												
7														
8														
9	LLNL ID#	Ar equil	Kr equil	Ar pxs	Kr pxs	Ar p	+-	Kr p	+-	normdev Ar	normdev Kr	chisqr	temp	+-
67	100628	3.50E-04	8.06E-08	2.37E-05	3.26E-09	3.73E-04	2.61E-06	8.39E-08	8.15E-10	-1.73	-0.89	3.8	14.2	1.0
68	100629	3.30E-04	7.49E-08	1.42E-05	1.95E-09	3.44E-04	1.56E-06	7.68E-08	4.88E-10	1.62	0.87	3.4	17.0	1.1
69	100630	3.59E-04	8.32E-08	2.62E-05	3.61E-09	3.85E-04	2.89E-06	8.68E-08	9.01E-10	-2.40	-1.25	7.3	13.0	1.0
70	100631	3.30E-04	7.49E-08	1.16E-05	1.60E-09	3.41E-04	1.28E-06	7.65E-08	3.99E-10	0.46	1.42	2.2	17.0	1.1
71	100632	3.30E-04	7.49E-08	1.88E-05	2.59E-09	3.49E-04	2.07E-06	7.74E-08	6.47E-10	0.31	-0.92	no Xe	no Xe	na
72	100633	3.30E-04	7.49E-08	2.16E-05	2.98E-09	3.51E-04	2.38E-06	7.78E-08	7.44E-10	0.26	-1.57	no Xe	no Xe	na
73	100634	3.37E-04	7.69E-08	9.71E-05	1.33E-08	4.34E-04	1.07E-05	9.02E-08	3.34E-09	1.08	1.15	2.5	16.0	1.6
74	100635	3.35E-04	7.64E-08	1.02E-04	1.40E-08	4.37E-04	1.12E-05	9.04E-08	3.49E-09	1.10	0.90	2.0	16.2	1.7
75	100636	3.34E-04	7.61E-08	3.20E-05	4.40E-09	3.66E-04	3.52E-06	8.05E-08	1.10E-09	-0.28	0.62	0.5	16.4	1.1
76	100637	2.88E-04	6.32E-08	2.98E-05	4.10E-09	3.18E-04	3.28E-06	6.73E-08	1.02E-09	6.90	6.62	91.5	bad fit	na
77	100638	3.19E-04	7.17E-08	1.60E-05	2.20E-09	3.35E-04	1.76E-06	7.39E-08	5.50E-10	1.68	1.01	3.8	18.7	1.0
78	100639	3.30E-04	7.49E-08	-5.37E-06	-7.38E-10	3.24E-04	-5.91E-07	7.41E-08	-1.85E-10	-4.61	-7.19	no Xe	no Xe	na
79	100640	3.31E-04	7.53E-08	9.36E-05	1.29E-08	4.25E-04	1.03E-05	8.82E-08	3.22E-09	0.00	0.07	0.0	16.7	1.6
80	100641	3.39E-04	7.74E-08	6.20E-05	8.52E-09	4.01E-04	6.82E-06	8.59E-08	2.13E-09	1.35	-0.37	2.0	15.7	1.3
81	100642	3.06E-04	6.82E-08	1.70E-04	2.34E-08	4.76E-04	1.87E-05	9.16E-08	5.84E-09	0.32	0.05	0.1	20.7	2.8
82	100643	3.47E-04	7.99E-08	3.62E-05	4.98E-09	3.83E-04	3.98E-06	8.48E-08	1.24E-09	-0.38	-1.72	3.1	14.5	1.1
83	100644	3.28E-04	7.44E-08	1.04E-04	1.42E-08	4.32E-04	1.14E-05	8.87E-08	3.56E-09	1.28	-1.13	2.9	17.2	1.7
84	100645	2.90E-04	6.37E-08	2.16E-04	2.97E-08	5.06E-04	2.38E-05	9.34E-08	7.43E-09	1.43	2.33	7.5	23.6	3.8
85	100646	3.24E-04	7.31E-08	8.21E-05	1.13E-08	4.06E-04	9.03E-06	8.44E-08	2.82E-09	1.24	-0.12	1.5	17.9	1.5
86	100647	3.32E-04	7.55E-08	1.01E-04	1.39E-08	4.33E-04	1.11E-05	8.94E-08	3.48E-09	1.04	1.53	3.4	16.7	1.7
87	100648	3.29E-04	7.46E-08	5.96E-05	8.19E-09	3.88E-04	6.55E-06	8.28E-08	2.05E-09	1.64	-0.52	3.0	17.1	1.3
88	100649	3.23E-04	7.30E-08	1.07E-04	1.47E-08	4.30E-04	1.17E-05	8.77E-08	3.67E-09	0.71	-0.36	0.6	18.0	1.8
89	100650	3.34E-04	7.61E-08	8.26E-05	1.13E-08	4.17E-04	9.08E-06	8.75E-08	2.84E-09	1.41	-0.33	2.1	16.4	1.5
90	100651	2.98E-04	6.59E-08	2.94E-04	4.05E-08	5.92E-04	3.24E-05	1.06E-07	1.01E-08	-2.70	-0.34	7.4	22.1	4.9
91	100652	3.16E-04	7.09E-08	4.17E-05	5.73E-09	3.57E-04	4.59E-06	7.66E-08	1.43E-09	0.38	-1.22	1.6	19.2	1.2
92	100653	3.30E-04	7.49E-08	1.00E-04	1.38E-08	4.30E-04	1.10E-05	8.87E-08	3.45E-09	2.14	0.66	no Xe	no Xe	na
93	100654	3.31E-04	7.51E-08	7.18E-05	9.87E-09	4.02E-04	7.90E-06	8.50E-08	2.47E-09	1.63	1.27	4.3	16.9	1.4
94	100655	3.30E-04	7.49E-08	5.59E-04	7.69E-08	8.89E-04	6.15E-05	1.52E-07	1.92E-08	-3.20	-1.35	12.0	bad fit	na
95	100656	3.41E-04	7.82E-08	6.80E-05	9.35E-09	4.09E-04	7.48E-06	8.75E-08	2.34E-09	1.43	-0.33	2.1	15.3	1.3
96	100657	3.30E-04	7.49E-08	9.51E-05	1.31E-08	4.25E-04	1.05E-05	8.79E-08	3.27E-09	0.17	-0.30	no Xe	no Xe	na
97	100658	3.30E-04	7.49E-08	3.16E-04	4.35E-08	6.46E-04	3.48E-05	1.18E-07	1.09E-08	-0.24	0.04	no Xe	no Xe	na
98	100659	3.45E-04	7.93E-08	8.50E-05	1.17E-08	4.30E-04	9.35E-06	9.10E-08	2.92E-09	2.05	0.77	4.8	14.8	1.4
99	100660	3.44E-04	7.89E-08	1.00E-04	1.38E-08	4.44E-04	1.10E-05	9.27E-08	3.45E-09	0.70	-0.32	0.6	15.0	1.6
100	100661	3.18E-04	7.15E-08	6.84E-05	9.40E-09	3.86E-04	7.52E-06	8.09E-08	2.35E-09	1.31	-0.07	1.7	18.8	1.4
101	100662	3.20E-04	7.22E-08	7.36E-05	1.01E-08	3.94E-04	8.09E-06	8.23E-08	2.53E-09	1.71	0.90	3.7	18.4	1.5
102	100663	3.24E-04	7.34E-08	2.43E-05	3.34E-09	3.49E-04	2.67E-06	7.67E-08	8.34E-10	1.23	0.26	1.6	17.8	1.1
103	100664	3.37E-04	7.69E-08	8.29E-05	1.14E-08	4.20E-04	9.12E-06	8.83E-08	2.85E-09	0.21	-0.23	0.1	16.0	1.5
104	100665	3.22E-04	7.27E-08	3.87E-05	5.32E-09	3.61E-04	4.25E-06	7.80E-08	1.33E-09	0.53	1.44	2.4	18.2	1.2
105	100666	2.99E-04	6.61E-08	2.72E-04	3.74E-08	5.70E-04	2.99E-05	1.03E-07	9.34E-09	0.51	-0.44	0.5	22.0	4.5
106	100667	3.38E-04	7.71E-08	5.05E-05	6.95E-09	3.88E-04	5.56E-06	8.40E-08	1.74E-09	0.87	2.25	5.8	15.9	1.2
107	1006													

6	A	B	C	D	E	F	G	H	I	J	K	L	M	N
7			Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.											
8		Well	Well name	Sample collection date	Dissolved gas analysis date	Tritium analysis date	Collection date	Dissolved gas analysis date	Tritium analysis date	At collection time	+/-	At dissolved gas meas time		⁴ He
9	LLNL ID#	type												(cm ³ STP/g)
125	100686	PS	DOWNEY 12	20001012	200110180242	200105141730	10/12/00	10/18/01	05/14/01	26.7	1.1	1.76E-06	1.76E-08	7.55E-08
126	100687	PS	IDAHO ST.	20001010	200103151830	200105141351	10/10/00	03/15/01	05/14/01	0.2	0.2	5.23E-07	5.23E-09	2.47E-07
127	100688	PS	BSMWC 615	20001011	200109060538	200110291735	10/11/00	09/06/01	10/29/01	21.1	1.0	2.43E-06	2.43E-08	7.08E-08
128	100689	PS	DOWNEY 14	20001012	200109051842	200110291523	10/12/00	09/05/01	10/29/01	31.1	1.2	1.90E-06	1.90E-08	9.51E-08
129	100690	PS	DOWNEY 15	20001012	200105100006	200109191450	10/12/00	05/10/01	09/19/01	41.8	2.0	2.55E-06	2.55E-08	7.82E-08
130	100691	PS	HUNTINGTON BEACH 01	20001010	200110250536	200110291903	10/10/00	10/25/01	10/29/01	0.4	0.3	1.38E-06	1.38E-08	6.65E-08
131	100692	PS	WESTMINSTER 125	20001010	200104180012	200110291607	10/10/00	04/18/01	10/29/01	0.2	0.3	1.30E-06	1.30E-08	5.49E-08
132	100693	PS	SANTA MONICA 1	20001023	200109280442	200110291651	10/23/00	09/28/01	10/29/01	14.0	0.8	1.15E-06	1.15E-08	1.00E-07
133	100694	PS	SANTA MONICA 3	20001023	200110200905	200111011545	10/23/00	10/20/01	11/01/01	10.9	0.6	1.52E-06	1.52E-08	6.98E-08
134	100695	PS	MAYWOOD 52 ST	20001025	200105161646	200111011713	10/25/00	05/16/01	11/01/01	19.7	0.9	2.42E-06	2.42E-08	9.50E-08
135	100696	PS	HERMOSA 8-02	20001026	200109052030	200111011841	10/26/00	09/05/01	11/01/01	65.3	2.5	5.43E-06	5.43E-08	6.00E-08
136	100697	PS	HUNTINGTON PARK 15	20001024	200105092035	200108281623	10/24/00	05/09/01	08/28/01	0.4	0.6	1.39E-06	1.39E-08	6.19E-08
137	100698	PS	VERNON 19	20001025	200105091850	200111011629	10/25/00	05/09/01	11/01/01	0.3	0.3	1.18E-06	1.18E-08	7.08E-08
138	100699	PS	MANHATTAN 05	20001024	200109070511	200111011757	10/24/00	09/07/01	11/01/01	-0.4	0.3	1.34E-06	1.34E-08	6.16E-08
139	100700	PS	GARDEN GROVE 16	20001023	200105091519	200111011925	10/23/00	05/09/01	11/01/01	-0.3	0.3	1.38E-06	1.38E-08	5.35E-08
140	100701	PS	SANTA MONICA 4	20001023	200105170330	200111012009	10/23/00	05/17/01	11/01/01	14.3	0.7	1.54E-06	1.54E-08	6.42E-08
141	100702	PS	HUNTINGTON PARK 12	20001024	200105171441	200110291948	10/24/00	05/17/01	10/29/01	32.6	1.4	2.88E-06	2.88E-08	7.68E-08
142	100703	PS	MANHATTAN 03A	20001024	200109150653	200111262107	10/24/00	09/15/01	11/26/01	1.0	0.5	1.35E-06	1.35E-08	7.26E-08
143	100704	PS	VERNON 18	20001025	200105171958	200110101849	10/25/00	05/17/01	10/10/01	0.2	0.3	1.39E-06	1.39E-08	6.09E-08
144	100705	PS	VERNON 14	20001025	200105161500	200110092209	10/25/00	05/16/01	10/09/01	0.3	0.3	1.32E-06	1.32E-08	7.94E-08
145	100706	PS	HERMOSA 22-01	20001026	200107040308	200107192102	10/26/00	07/04/01	07/19/01	33.0	1.5	3.46E-06	3.46E-08	6.62E-08
146	100707	PS	HERMOSA 30-01	20001026	200107040459	200108030031	10/26/00	07/04/01	08/03/01	2.7	0.3	1.34E-06	1.34E-08	6.58E-08
147	100708	PS	ORANGE 25	20001026	200109061816	200110091958	10/26/00	09/06/01	10/09/01	3.4	0.4	1.50E-06	1.50E-08	9.79E-08
148	100709	PS	HAWTHORNE 9M1 (WELL 13)	20001025	nm	200108022347	10/25/00	nc	08/02/01	-0.6	0.4			
149	100710	PS	DOMINGUEZ 33	20001024	200105071913	200110091746	10/24/00	05/07/01	10/09/01	65.2	2.5	5.73E-06	5.73E-08	6.97E-08
150	100711	PS	IRVINE 3 (DYER ROAD)	20000927	200103282337	200110101805	09/27/00	03/28/01	10/10/01	0.2	0.3	9.13E-07	9.13E-09	8.49E-08
151	100712	PS	HUNTINGTON BEACH 09	20000926	200104303154	200108301752	09/26/00	04/03/01	08/30/01	0.2	0.7	1.31E-06	1.31E-08	5.31E-08
152	100713	PS	GARDEN GROVE 19	20000926	200103301907	200109181518	09/26/00	03/30/01	09/18/01	43.4	1.8	2.60E-06	2.60E-08	9.04E-08
153	100714	PS	IRVINE 5	20000927	nm	200109181940	09/27/00	nc	09/18/01	-0.1	0.3			
154	100715	PS	GARDEN GROVE 27	20000926	200104041538	200109191745	09/26/00	04/04/01	09/19/01	27.1	1.2	2.62E-06	2.62E-08	7.66E-08
155	100719	PS	ORANGE 24	20001026	200109062154	200110102016	10/26/00	09/06/01	10/10/01	13.6	0.8	1.51E-06	1.51E-08	2.50E-07
156	100720	PS	HAWTHORNE 9N4 (WELL 4)	20001025	200106122026	200108022051	10/25/00	06/12/01	08/02/01	-1.2	0.5	1.35E-06	1.35E-08	1.25E-08
157	100721	PS	PEERLESS 10	20001024	200106191542	200108031811	10/24/00	06/19/01	08/03/01	1.0	0.4	1.41E-06	1.41E-08	5.40E-08
158	100722	PS	LOS ALISOS 2	20001026	200106191732	200108032144	10/26/00	06/19/01	08/03/01	0.1	0.6	1.15E-06	1.15E-08	8.08E-08
159	100723	PS	HAWTHORNE 9N5 (WELL 12)	20001025	200106191255	200108032102	10/25/00	06/19/01	08/03/01	0.6	0.4	4.59E-07	4.59E-09	5.17E-08
160	100724	PS	MESA 09	20001026	200105171813	200109192040	10/26/00	05/17/01	09/19/01	9.4	0.6	1.32E-06	1.32E-08	6.38E-08
161	100725	PS	TUSTIN COLUMBUS	20001023	200105172145	200110092042	10/23/00	05/17/01	10/09/01	3.1	0.4	1.81E-06	1.81E-08	5.30E-07
162	100726	PS												

	A	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.																
7		+/-	Ne	+/-	Ar	+/-	Kr	+/-	Xe	+/-							
8	LLNL ID #	(cm³STP/g)	USGS ID #	State ID #	T(C) est	update	Altitude	pressure									
9																He equil	
125	100686	1.51E-09	3.21E-07	6.43E-09	3.99E-04	7.97E-06	8.84E-08	2.65E-09	1.08E-08	3.23E-10	335810118070201	03S/12W-02H04 S	19.0	19.0	30	0.996	4.49E-08
126	100687	2.47E-09	2.56E-07	5.12E-09	3.67E-04	7.34E-06	7.75E-08	1.55E-09			335526117573201	03S/10W-07J02 S	17.0	17.0	30	0.996	4.52E-08
127	100688	1.42E-09	2.91E-07	5.81E-09	4.04E-04	8.07E-06	8.25E-08	2.48E-09	1.14E-08	3.43E-10	335209118082001	03S/12W-33B01 S	16.1	16.1	30	0.996	4.54E-08
128	100689	1.90E-09	3.78E-07	7.55E-09	4.47E-04	8.94E-06	8.85E-08	2.66E-09	1.12E-08	3.37E-10	335654118074401	02S/12W-34P01 S	18.7	18.7	30	0.996	4.49E-08
129	100690	1.56E-09	3.29E-07	6.58E-09	4.17E-04	8.35E-06	8.35E-08	2.51E-09	1.14E-08	3.43E-10	335609118064001	03S/12W-02L01 S	17.0	17.0	30	0.996	4.52E-08
130	100691	1.33E-09	2.81E-07	5.61E-09	4.04E-04	8.09E-06	8.37E-08	2.51E-09	1.11E-08	3.32E-10	334439118011801	05S/11W-15D03 S	17.0	17.0	30	0.996	4.52E-08
131	100692	1.10E-09	2.12E-07	4.24E-09	3.48E-04	6.95E-06	8.33E-08	2.50E-09	1.19E-08	3.57E-10	334552118020201	05S/11W-04L01 S	13.1	13.1	30	0.996	4.59E-08
132	100693	2.00E-09	2.18E-07	4.37E-09	3.48E-04	6.96E-06	7.93E-08	2.38E-09	1.12E-08	3.35E-10	340235118295901	01S/15W-31E01 S	15.3	15.3	30	0.996	4.55E-08
133	100694	1.40E-09	3.19E-07	6.39E-09	3.64E-04	7.28E-06	8.23E-08	2.47E-09	1.01E-08	3.04E-10	340152118273601	02S/15W-04C02 S	21.2	21.2	30	0.996	4.46E-08
134	100695	1.90E-09	3.08E-07	6.17E-09	4.09E-04	8.19E-06	8.40E-08	2.52E-09	1.17E-08	3.51E-10	335938118110501	02S/12W-18M01 S	15.6	15.6	30	0.996	4.54E-08
135	100696	1.20E-09	2.11E-07	4.22E-09	3.42E-04	6.85E-06	7.68E-08	2.30E-09	1.05E-08	3.15E-10	335219118215501	03S/14W-32A02 S	17.2	17.2	30	0.996	4.52E-08
136	100697	1.24E-09	2.65E-07	5.30E-09	3.86E-04	7.72E-06	8.19E-08	2.46E-09	1.15E-08	3.44E-10	33584118135801	02S/13W-22P02 S	15.4	15.4	30	0.996	4.55E-08
137	100698	1.42E-09	2.54E-07	5.07E-09	3.75E-04	7.50E-06	8.11E-08	2.43E-09	1.11E-08	3.32E-10	335952118122601	02S/13W-14H05 S	16.4	16.4	30	0.996	4.53E-08
138	100699	1.23E-09	2.50E-07	4.99E-09	3.65E-04	7.30E-06	7.82E-08	2.35E-09	1.07E-08	3.20E-10	335858118183501	02S/14W-23H14 S	17.6	17.6	30	0.996	4.51E-08
139	100700	1.07E-09	2.46E-07	4.92E-09	3.71E-04	7.41E-06	8.19E-08	2.46E-09	1.11E-08	3.34E-10	334652118021401	04S/11W-33L01 S	16.0	16.0	30	0.996	4.54E-08
140	100701	1.28E-09	2.45E-07	4.90E-09	3.53E-04	7.06E-06	7.66E-08	2.30E-09	1.04E-08	3.11E-10	340150118274801	02S/15W-04A01 S	18.5	18.5	30	0.996	4.50E-08
141	100702	1.54E-09	2.94E-07	5.88E-09	4.12E-04	8.25E-06	8.60E-08	2.58E-09	1.12E-08	3.36E-10	335742118113301	02S/13W-25Q01 S	16.9	16.9	30	0.996	4.52E-08
142	100703	1.45E-09	3.04E-07	6.09E-09	3.91E-04	7.81E-06	8.50E-08	2.55E-09	1.11E-08	3.33E-10	335858118183901	02S/14W-23H02 S	17.4	17.4	30	0.996	4.51E-08
143	100704	1.22E-09	2.38E-07	4.77E-09	3.78E-04	7.56E-06	8.20E-08	2.46E-09	1.09E-08	3.27E-10	335947118140401	02S/13W-15E02 S	16.5	16.5	30	0.996	4.53E-08
144	100705	1.59E-09	3.00E-07	6.00E-09	4.11E-04	8.23E-06	8.85E-08	2.66E-09	1.19E-08	3.58E-10	340044118131101	02S/13W-11E04 S	14.8	14.8	30	0.996	4.56E-08
145	100706	1.32E-09	2.79E-07	5.59E-09	3.79E-04	7.58E-06	1.16E-06	3.47E-08	1.04E-08	3.11E-10	335247118215201	03S/14W-29J01 S	19.3	19.3	30	0.996	4.49E-08
146	100707	1.32E-09	2.22E-07	4.45E-09	5.76E-04	1.15E-05	8.01E-08	2.40E-09	1.10E-08	3.29E-10	335252118214201	03S/14W-29H01 S	15.9	15.9	30	0.996	4.54E-08
147	100708	1.96E-09	3.62E-07	7.25E-09	4.20E-04	8.40E-06	8.74E-08	2.62E-09	1.10E-08	3.29E-10	337707117502601	04S/09W-32B04 S	19.4	19.4	30	0.996	4.48E-08
148	100709										335518118213501	03S/14W-09M01 S	17.0	17.0	30	0.996	4.52E-08
149	100710	1.39E-09	1.98E-07	3.96E-09	3.31E-04	6.62E-06	7.39E-08	2.22E-09	9.75E-09	2.93E-10	335042118203001	04S/14W-10D04 S	19.4	19.4	30	0.996	4.48E-08
150	100711	2.55E-09	2.12E-07	4.24E-09	3.40E-04	6.81E-06	7.37E-08	1.47E-09			334244117512901	05S/09W-30G02 S	17.0	17.0	30	0.996	4.52E-08
151	100712	5.31E-10	2.12E-07	4.25E-09	3.43E-04	6.87E-06	7.79E-08	1.56E-09			334258117582701	05S/11W-24R04 S	17.0	17.0	30	0.996	4.52E-08
152	100713	9.04E-10	3.57E-07	7.13E-09	4.31E-04	8.61E-06	8.83E-08	1.77E-09			334745117564501	04S/10W-27K01 S	17.0	17.0	30	0.996	4.52E-08
153	100714										334238117520001	05S/09W-30E01 S	17.0	17.0	30	0.996	4.52E-08
154	100715	1.53E-09	2.94E-07	5.88E-09	4.13E-04	8.26E-06	8.31E-08	2.49E-09	5.79E-09	1.74E-10	334747117582701	04S/10W-30E02 S	17.0	17.0			

	A	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.																	
7		excess		excess		Xe equil												
8		Ne	Ne xs	Xe	+-	(alt = 0)	+-	T(C)				Meas	Mean nonrad					
9	LLNL ID#	Ne equil	(cm ³ STP/g)	as air	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	calculation	+-	⁴ He/Ne	⁴ He/Ne	+-	⁴ He rad	+-	⁴ He rad	+-	rad cor
125	100686	1.86E-07	1.35E-07	0.0074	9.70E-10	3.23E-10	9.83E-09	4.57E-10	19.0	1.5	0.235	0.251	0.014	-5.10E-09	4.71E-09	0.00E+00	4.71E-09	1.76E-06
126	100687	1.90E-07	6.64E-08	0.0037	4.77E-10	1.59E-10	-4.78E-10	1.59E-10	no Xe	no Xe	0.965	0.245	0.009	1.84E-07	4.51E-09	1.84E-07	4.51E-09	1.47E-06
127	100688	1.91E-07	9.96E-08	0.0055	7.15E-10	2.38E-10	1.07E-08	4.17E-10	16.1	1.2	0.244	0.246	0.012	-6.79E-10	3.78E-09	0.00E+00	3.78E-09	2.43E-06
128	100689	1.87E-07	1.91E-07	0.0105	1.37E-09	4.57E-10	9.92E-09	5.68E-10	18.7	1.9	0.252	0.252	0.017	-1.81E-10	6.57E-09	0.00E+00	6.57E-09	1.90E-06
129	100690	1.90E-07	1.39E-07	0.0077	1.00E-09	3.33E-10	1.05E-08	4.78E-10	17.0	1.5	0.238	0.249	0.015	-3.58E-09	5.07E-09	0.00E+00	5.07E-09	2.55E-06
130	100691	1.90E-07	9.10E-08	0.0050	6.54E-10	2.18E-10	1.05E-08	3.97E-10	17.0	1.2	0.237	0.246	0.011	-2.64E-09	3.42E-09	0.00E+00	3.42E-09	1.38E-06
131	100692	1.96E-07	1.57E-08	0.0009	1.13E-10	3.75E-11	1.18E-08	3.59E-10	13.1	0.9	0.259	0.236	0.003	4.97E-09	1.17E-09	4.97E-09	1.17E-09	1.41E-06
132	100693	1.92E-07	2.60E-08	0.0014	1.87E-10	6.22E-11	1.10E-08	3.40E-10	15.3	1.0	0.458	0.240	0.004	4.78E-08	1.70E-09	4.78E-08	1.70E-09	2.03E-06
133	100694	1.83E-07	1.36E-07	0.0075	9.77E-10	3.26E-10	9.20E-09	4.46E-10	21.2	1.6	0.219	0.253	0.013	-1.09E-08	4.52E-09	0.00E+00	4.52E-09	1.52E-06
134	100695	1.92E-07	1.16E-07	0.0064	8.36E-10	2.79E-10	1.09E-08	4.48E-10	15.6	1.3	0.308	0.246	0.013	1.90E-08	4.43E-09	1.90E-08	4.43E-09	2.98E-06
135	100696	1.89E-07	2.16E-08	0.0012	1.55E-10	5.17E-11	1.04E-08	3.19E-10	17.2	1.0	0.285	0.241	0.004	9.13E-09	1.27E-09	9.13E-09	1.27E-09	6.37E-06
136	100697	1.92E-07	7.29E-08	0.0040	5.23E-10	1.74E-10	1.10E-08	3.85E-10	15.4	1.1	0.234	0.244	0.010	-2.66E-09	2.91E-09	0.00E+00	2.91E-09	1.39E-06
137	100698	1.91E-07	6.31E-08	0.0035	4.53E-10	1.51E-10	1.06E-08	3.65E-10	16.4	1.1	0.279	0.244	0.009	8.94E-09	2.53E-09	8.94E-09	2.53E-09	1.32E-06
138	100699	1.89E-07	6.10E-08	0.0034	4.38E-10	1.46E-10	1.03E-08	3.52E-10	17.6	1.1	0.247	0.245	0.008	3.87E-10	2.40E-09	3.87E-10	2.40E-09	1.35E-06
139	100700	1.91E-07	5.46E-08	0.0030	3.92E-10	1.31E-10	1.08E-08	3.59E-10	16.0	1.1	0.218	0.243	0.008	-6.22E-09	2.27E-09	0.00E+00	2.27E-09	1.38E-06
140	100701	1.87E-07	5.80E-08	0.0032	4.16E-10	1.39E-10	9.98E-09	3.40E-10	18.5	1.1	0.262	0.246	0.008	3.94E-09	2.27E-09	3.94E-09	2.27E-09	1.63E-06
141	100702	1.90E-07	1.04E-07	0.0057	7.48E-10	2.49E-10	1.05E-08	4.18E-10	16.9	1.3	0.261	0.247	0.012	4.24E-09	3.88E-09	4.24E-09	3.88E-09	3.04E-06
142	100703	1.89E-07	1.16E-07	0.0064	8.30E-10	2.77E-10	1.03E-08	4.33E-10	17.4	1.4	0.238	0.248	0.013	-2.96E-09	4.21E-09	0.00E+00	4.21E-09	1.35E-06
143	100704	1.90E-07	4.82E-08	0.0027	3.46E-10	1.15E-10	1.06E-08	3.47E-10	16.5	1.0	0.255	0.243	0.007	2.92E-09	2.04E-09	2.92E-09	2.04E-09	1.45E-06
144	100705	1.93E-07	1.07E-07	0.0059	7.65E-10	2.55E-10	1.12E-08	4.39E-10	14.8	1.2	0.265	0.245	0.013	5.94E-09	4.14E-09	5.94E-09	4.14E-09	1.41E-06
145	100706	1.86E-07	9.35E-08	0.0051	6.71E-10	2.24E-10	9.74E-09	3.83E-10	19.3	1.3	0.237	0.249	0.011	-3.35E-09	3.34E-09	0.00E+00	3.34E-09	3.46E-06
146	100707	1.91E-07	3.10E-08	0.0017	2.22E-10	7.41E-11	1.08E-08	3.38E-10	15.9	1.0	0.296	0.241	0.005	1.23E-08	1.55E-09	1.23E-08	1.55E-09	1.60E-06
147	100708	1.86E-07	1.76E-07	0.0097	1.27E-09	4.22E-10	9.72E-09	5.35E-10	19.4	1.8	0.270	0.252	0.016	6.46E-09	6.01E-09	6.46E-09	6.01E-09	1.59E-06
148	100709	1.90E-07	-1.90E-07	-0.0104	-1.36E-09	-4.53E-10	1.37E-09	4.53E-10	no Xe	no Xe	nc	nc	nc	nc	nc	nc	nc	
149	100710	1.86E-07	1.21E-08	0.0007	8.71E-11	2.90E-11	9.70E-09	2.94E-10	19.4	1.0	0.352	0.243	0.002	2.17E-08	1.12E-09	2.17E-08	1.12E-09	8.23E-06
150	100711	1.90E-07	2.25E-08	0.0012	1.61E-10	5.37E-11	-1.62E-10	5.37E-11	no Xe	no Xe	0.401	0.241	0.004	3.38E-08	1.45E-09	3.38E-08	1.45E-09	1.39E-06
151	100712	1.90E-07	2.28E-08	0.0013	1.64E-10	5.45E-11	-1.64E-10	5.45E-11	no Xe	no Xe	0.250	0.241	0.004	1.94E-09	1.29E-09	1.94E-09	1.29E-09	1.35E-06
152	100713	1.90E-07	1.67E-07	0.0092	1.20E-09	4.00E-10	-1.20E-09	4.00E-10	no Xe	no Xe	0.254	0.250	0.016	1.29E-09	6.01E-09	1.29E-09	6.01E-09	2.63E-06
153	100714	1.90E-07	-1.90E-07	-0.0104	-1.36E-09	-4.53E-10	1.37E-09	4.53E-10	no Xe	no Xe	nc	nc	nc	nc	nc	nc	nc	
154	100715	1.90E-07	1.05E-															

	A	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.															
7		Excess air								Assume no rad ⁴ He						
8		⁴ He	Air derived	³ He from ³ H	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	Age	(yr)	(pCi/L)	(pCi/L)	Age	(yr)	vintage	initial ³ H	estimate
9	LLNL ID#	+-	(cm ³ STP/g)	3He/4He	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	(yr)	(yr)	(pCi/L)	(pCi/L)	(yr)	(yr)	initial ³ H	% premod	
125	100686	9.88E-08	3.88E-08	1.37E-06	2.79E-14	7.46E-15	14	3	2.79E-14	1.33E-15	14	1	07/19/86	59.3	-5%	
126	100687	5.89E-07	1.91E-08	1.36E-06	6.80E-15	3.69E-14	>50	0	-2.08E-13	1.29E-15	>50	0	na	na	100%	
127	100688	1.22E-07	2.86E-08	1.37E-06	7.42E-14	8.61E-15	30	2	7.42E-14	1.72E-15	30	1	03/13/71	111.3	71%	
128	100689	1.19E-07	5.48E-08	1.38E-06	4.91E-14	1.13E-14	19	3	4.91E-14	1.81E-15	19	1	11/25/81	90.0	1%	
129	100690	1.54E-07	4.00E-08	1.37E-06	9.08E-14	1.21E-14	23	2	9.08E-14	1.99E-15	23	1	07/23/77	154.2	2%	
130	100691	6.23E-08	2.61E-08	1.37E-06	5.14E-16	4.14E-15	>50	0	5.14E-16	9.17E-16	>50	0	na	na	100%	
131	100692	3.55E-08	4.50E-09	1.36E-06	2.31E-15	1.77E-15	>50	0	-3.48E-15	7.15E-16	>50	0	na	na	100%	
132	100693	1.87E-07	7.47E-09	1.36E-06	3.40E-14	9.76E-15	24	4	-2.17E-14	1.15E-15	nc	-1	06/05/76	54.9	70%	
133	100694	8.65E-08	3.91E-08	1.37E-06	9.39E-15	6.04E-15	12	6	9.39E-15	1.06E-15	12	1	06/13/88	21.8	55%	
134	100695	1.42E-07	3.34E-08	1.37E-06	1.21E-13	1.08E-14	38	2	9.91E-14	2.30E-15	35	1	05/06/62	171.2	89%	
135	100696	1.50E-07	6.20E-09	1.37E-06	2.52E-13	7.62E-15	31	1	2.42E-13	3.26E-15	30	1	10/18/69	372.9	23%	
136	100697	5.74E-08	2.09E-08	1.37E-06	9.84E-16	3.55E-15	>50	0	9.84E-16	8.58E-16	>50	0	na	na	100%	
137	100698	5.13E-08	1.81E-08	1.37E-06	-2.84E-15	3.17E-15	>50	0	-1.33E-14	8.36E-16	>50	0	na	na	100%	
138	100699	4.68E-08	1.75E-08	1.37E-06	-1.37E-15	2.86E-15	>50	0	-1.82E-15	8.24E-16	>50	0	na	na	100%	
139	100700	5.17E-08	1.57E-08	1.37E-06	3.25E-16	2.76E-15	>50	0	3.25E-16	7.35E-16	>50	0	na	na	100%	
140	100701	5.47E-08	1.67E-08	1.37E-06	1.53E-14	3.30E-15	15	2	1.07E-14	9.89E-16	12	1	11/17/85	33.0	45%	
141	100702	1.47E-07	2.99E-08	1.37E-06	1.20E-13	1.07E-14	31	1	1.15E-13	2.21E-15	30	1	03/17/70	182.1	60%	
142	100703	6.79E-08	3.32E-08	1.37E-06	-1.92E-15	4.93E-15	>50	0	-1.92E-15	9.78E-16	>50	0	na	na	100%	
143	100704	4.56E-08	1.38E-08	1.37E-06	4.89E-15	2.64E-15	>50	0	1.49E-15	8.47E-16	>50	0	na	na	100%	
144	100705	6.64E-08	3.06E-08	1.37E-06	2.52E-15	4.88E-15	>50	0	-4.43E-15	1.04E-15	>50	0	na	na	100%	
145	100706	1.68E-07	2.68E-08	1.37E-06	1.38E-13	1.11E-14	32	1	1.38E-13	2.29E-15	32	1	06/21/68	202.8	66%	
146	100707	5.91E-08	8.90E-09	1.37E-06	1.25E-14	3.16E-15	34	4	-1.88E-15	8.82E-16	-41	0	12/08/66	18.2	98%	
147	100708	8.80E-08	5.07E-08	1.37E-06	1.97E-14	8.05E-15	37	7	1.21E-14	1.47E-15	30	1	06/21/63	27.5	98%	
148	100709	nc	-5.44E-08	nc	nc	>50	0	nc	0.00E+00	>50	0	na	na	100%		
149	100710	1.78E-07	3.48E-09	1.36E-06	3.28E-13	8.57E-15	35	1	3.03E-13	4.00E-15	34	1	06/19/65	475.0	50%	
150	100711	1.35E-07	6.45E-09	1.36E-06	1.06E-15	6.89E-15	>50	0	-3.84E-14	7.76E-16	>50	0	na	na	100%	
151	100712	3.20E-08	6.54E-09	1.37E-06	-7.62E-16	1.64E-15	>50	0	-3.02E-15	6.95E-16	>50	0	na	na	100%	
152	100713	1.64E-07	4.80E-08	1.37E-06	1.11E-13	1.46E-14	26	2	1.10E-13	2.35E-15	25	1	03/24/75	181.9	15%	
153	100714	nc	-5.44E-08	nc	nc	>50	0	nc	0.00E+00	>50	0	na	na	100%		
154	100715	1.32E-07	3.01E-08	1.37E-06	9.93E-14	9.63E-15	31	2	9.48E-14	2.00E-15	30	1	02/19/70	151.0	67%	
155	100719	1.42E-07	1.89E-07	1.38E-06	6.84E-14	3.10E-14	35	7	3.15E-14	3.76E-15	24	1	10/29/65	97.2	89%	
156	100720	2.10E-05	1.87E-06	4.47E-06	-3.90E-14	2.63E-13	>50	0	-3.90E-14	1.68E-16	>50	0	na	na	100%	
157	100721	4.45E-08	1.21E-08	1.37E-06	2.30E-15	2.40E-15	>50	0	2.30E-15	7.62E-16	>50	0	na	na	100%	
158	100722	5.71E-08	2.83E-08	1.37E-06	-6.77E-15	4.06E-15	>50	0	-1.82E-14	9.25E-16	>50	0	na	na	100%	
159	100723	1.48E-05	-4.86E-08	1.34E-06	1.26E-14	1.03E-14	>50	0	-4.58E-14	2.38E-16	>50	0	na	na	100%	
160	100724	6.30E-08	5.59E-09	1.37E-06	1.26E-14	3.16E-15	17	3	-3.22E-15	8.41E-16	-11	0	06/12/83	24.9	67%	
161	100725	2.26E-07	3.07E-07	1.38E-06	4.71E-13	7.36E-14	93	4	2.31E-13	9.61E-15	81	1	05/30/07	593.3	100%	
162	100726	7.99E-08	2.07E-08	1.37E-06	3.00E-14	4.99E-15	28	3	3.00E-14	1.16E-15	28	1	09/18/72	46.7	85%	
163	100727	4.91E-08	1.38E-08	1.37E-06	1.09E-14	2.84E-15	9	2	7.47E-15	9.14E-16	6	1	12/17/91	31.4	18%	
164	100728	2.14E-07	8.27E-08	1.37E-06	2.12E-13	2.59E-14	48	2	9.61E-14	3.98E-15	35	0	02/22/53			

	A	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV
6		Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.												
7														
8														
9	LLNL ID#	Ar equil	Kr equil	Ar pxs	Kr pxs	Ar p	+-	Kr p	+-	normdev Ar	normdev Kr	chisqr	temp	+-
125	100686	3.17E-04	7.12E-08	7.70E-05	1.06E-08	3.94E-04	8.48E-06	8.18E-08	2.65E-09	0.43	1.77	3.3	19.0	1.5
126	100687	3.30E-04	7.49E-08	3.79E-05	5.20E-09	3.68E-04	4.16E-06	8.01E-08	1.30E-09	-0.07	-1.27	no Xe	no Xe	na
127	100688	3.36E-04	7.66E-08	5.68E-05	7.81E-09	3.93E-04	6.25E-06	8.44E-08	1.95E-09	1.06	-0.60	1.5	16.1	1.2
128	100689	3.19E-04	7.17E-08	1.09E-04	1.50E-08	4.27E-04	1.20E-05	8.67E-08	3.74E-09	1.31	0.41	1.9	18.7	1.9
129	100690	3.30E-04	7.49E-08	7.95E-05	1.09E-08	4.10E-04	8.74E-06	8.59E-08	2.73E-09	0.65	-0.64	0.8	17.0	1.5
130	100691	3.30E-04	7.49E-08	5.19E-05	7.14E-09	3.82E-04	5.71E-06	8.20E-08	1.78E-09	2.27	0.53	5.4	17.0	1.2
131	100692	3.58E-04	8.31E-08	8.94E-06	1.23E-09	3.67E-04	9.84E-07	8.43E-08	3.07E-10	-2.81	-0.41	8.1	13.1	0.9
132	100693	3.41E-04	7.82E-08	1.48E-05	2.04E-09	3.56E-04	1.63E-06	8.02E-08	5.09E-10	-1.17	-0.38	1.5	15.3	1.0
133	100694	3.03E-04	6.75E-08	7.76E-05	1.07E-08	3.81E-04	8.54E-06	7.81E-08	2.67E-09	-1.51	1.15	3.6	21.2	1.6
134	100695	3.39E-04	7.76E-08	6.64E-05	9.13E-09	4.06E-04	7.31E-06	8.67E-08	2.28E-09	0.34	-0.78	0.7	15.6	1.3
135	100696	3.28E-04	7.44E-08	1.23E-05	1.69E-09	3.41E-04	1.35E-06	7.61E-08	4.23E-10	0.25	0.29	0.1	17.2	1.0
136	100697	3.41E-04	7.80E-08	4.16E-05	5.71E-09	3.82E-04	4.57E-06	8.37E-08	1.43E-09	0.43	-0.64	0.6	15.4	1.1
137	100698	3.34E-04	7.60E-08	3.60E-05	4.94E-09	3.70E-04	3.96E-06	8.10E-08	1.24E-09	0.63	0.03	0.4	16.4	1.1
138	100699	3.26E-04	7.38E-08	3.48E-05	4.78E-09	3.61E-04	3.83E-06	7.86E-08	1.20E-09	0.50	-0.14	0.3	17.6	1.1
139	100700	3.37E-04	7.69E-08	3.11E-05	4.28E-09	3.68E-04	3.43E-06	8.11E-08	1.07E-09	0.32	0.27	0.2	16.0	1.1
140	100701	3.20E-04	7.21E-08	3.31E-05	4.55E-09	3.53E-04	3.64E-06	7.66E-08	1.14E-09	0.04	0.00	0.0	18.5	1.1
141	100702	3.31E-04	7.51E-08	5.94E-05	8.17E-09	3.90E-04	6.54E-06	8.33E-08	2.04E-09	2.11	0.83	5.1	16.9	1.3
142	100703	3.27E-04	7.40E-08	6.59E-05	9.06E-09	3.93E-04	7.25E-06	8.31E-08	2.27E-09	-0.19	0.57	0.4	17.4	1.4
143	100704	3.33E-04	7.57E-08	2.75E-05	3.78E-09	3.60E-04	3.02E-06	7.95E-08	9.45E-10	2.17	0.93	5.6	16.5	1.0
144	100705	3.45E-04	7.93E-08	6.08E-05	8.35E-09	4.06E-04	6.68E-06	8.77E-08	2.09E-09	0.50	0.26	0.3	14.8	1.2
145	100706	3.15E-04	7.07E-08	5.33E-05	7.33E-09	3.68E-04	5.86E-06	7.80E-08	1.83E-09	1.14	31.05	965.1	bad fit	na
146	100707	3.37E-04	7.70E-08	1.77E-05	2.43E-09	3.55E-04	1.94E-06	7.94E-08	6.07E-10	18.94	0.28	358.7	bad fit	na
147	100708	3.14E-04	7.05E-08	1.01E-04	1.38E-08	4.15E-04	1.11E-05	8.44E-08	3.46E-09	0.35	0.69	0.6	19.4	1.8
148	100709	3.30E-04	7.49E-08	-1.08E-04	-1.49E-08	2.22E-04	-1.19E-05	6.00E-08	-3.71E-09	-18.64	-16.16	no Xe	no Xe	na
149	100710	3.14E-04	7.04E-08	6.92E-06	9.51E-10	3.21E-04	7.61E-07	7.14E-08	2.38E-10	1.50	1.13	3.5	19.4	1.0
150	100711	3.30E-04	7.49E-08	1.28E-05	1.76E-09	3.43E-04	1.41E-06	7.66E-08	4.40E-10	-0.32	-1.86	no Xe	no Xe	na
151	100712	3.30E-04	7.49E-08	1.30E-05	1.79E-09	3.43E-04	1.43E-06	7.66E-08	4.46E-10	0.09	0.80	no Xe	no Xe	na
152	100713	3.30E-04	7.49E-08	9.52E-05	1.31E-08	4.25E-04	1.05E-05	8.79E-08	3.27E-09	0.42	0.08	no Xe	no Xe	na
153	100714	3.30E-04	7.49E-08	-1.08E-04	-1.49E-08	2.22E-04	-1.19E-05	6.00E-08	-3.71E-09	-18.64	-16.16	no Xe	no Xe	na
154	100715	3.30E-04	7.49E-08	5.97E-05	8.21E-09	3.89E-04	6.57E-06	8.31E-08	2.05E-09	2.24	0.02	5.0	17.0	1.9
155	100719	3.30E-04	7.49E-08	3.76E-04	5.16E-08	7.05E-04	4.13E-05	1.26E-07	1.29E-08	-4.72	-1.49	24.5	bad fit	na
156	100720	3.30E-04	7.49E-08	3.71E-03	5.10E-07	4.04E-03	4.08E-04	5.85E-07	1.28E-07	-8.62	-2.97	83.2	bad fit	na
157	100721	3.42E-04	7.84E-08	2.39E-05	3.29E-09	3.66E-04	2.63E-06	8.17E-08	8.23E-10	2.20	1.12	6.1	15.2	1.0
158	100722	3.26E-04	7.37E-08	5.62E-05	7.73E-09	3.82E-04	6.18E-06	8.14E-08	1.93E-09	2.60	1.34	8.5	17.6	1.3
159	100723	3.30E-04	7.49E-08	-9.66E-05	-1.33E-08	2.33E-04	-1.06E-05	6.16E-08	-3.32E-09	22.00	-18.49	826.1	bad fit	na
160	100724	3.24E-04	7.32E-08	1.11E-05	1.53E-09	3.35E-04	1.22E-06	7.48E-08	3.82E-10	2.09	1.20	5.8	17.9	1.0
161	100725	3.30E-04	7.49E-08	6.10E-04	8.38E-08	9.39E-04	6.71E-05	1.59E-07	2.09E-08	-3.52	-0.98	13.4	bad fit	na
162	100726	3.48E-04	8.00E-08	4.11E-05	5.65E-09	3.89E-04	4.53E-06	8.56E-08	1.41E-09	1.43	0.94	2.9	14.5	1.1
163	100727	3.28E-04	7.44E-08	2.75E-05	3.77E-09	3.56E-04	3.02E-06	7.82E-08	9.43E-10	0.64	0.06	0.4	17.2	1.1
164	100728	3.22E-04	7.27E-08	1.64E-04	2.26E-08	4.86E-04								

6	A	B	C	D	E	F	G	H	I	J	K	L	M	N
7			Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.											
8		Well	Well name	Sample collection date	Dissolved gas analysis date	Tritium analysis date	Collection date	Dissolved gas analysis date	Tritium analysis date	At collection time	+/-	At dissolved gas meas time		⁴ He
9	LLNL ID#	type												(cm ³ STP/g)
183	100747	PS	DOWNEY 16	20001108	200105181327	200106251533	11/08/00	05/18/01	06/25/01	37.2	1.5	2.22E-06	2.22E-08	7.97E-08
184	100748	PS	DOWNEY 01	20001108	200105181704	200106251930	11/08/00	05/18/01	06/25/01	30.9	1.3	2.22E-06	2.22E-08	6.70E-08
185	100749	PS	COMPTON 14	20001108	200106212028	200108301541	11/08/00	06/21/01	08/30/01	-0.7	0.7	1.14E-06	1.14E-08	6.81E-08
186	100750	PS	DOWNEY 08	20001106	200110161919	200107191753	11/06/00	10/16/01	07/19/01	20.5	1.1	1.54E-06	1.54E-08	8.55E-08
187	100751	PS	DOWNEY 05	20001106	200106211838	200108281832	11/06/00	06/21/01	08/28/01	17.1	1.0	1.63E-06	1.63E-08	1.13E-07
188	100752	PS	DOWNEY 02	20001106	200110162109	bottle broken	11/06/00	10/16/01				1.60E-06	1.60E-08	9.07E-08
189	100753	PS	MONTEBELLO 12	20001107	200106061831	200107202119	11/07/00	06/06/01	07/20/01	25.3	1.2	1.96E-06	1.96E-08	5.57E-08
190	100754	PS	MONTEBELLO 8A	20001107	200110162259	200107191619	11/07/00	10/16/01	07/19/01	22.6	1.1	1.93E-06	1.93E-08	7.09E-08
191	100755	PS	PICO RIVERA W3	20001107	200109150504	200108030242	11/07/00	09/15/01	08/03/01	24.4	0.9	1.58E-06	1.58E-08	8.92E-08
192	100756	PS	PICO RIVERA W5	20001107	200106061642	200108030158	11/07/00	06/06/01	08/03/01	23.2	1.1	1.51E-06	1.51E-08	8.03E-08
193	100757	PS	WHITTIER 14	20001107	200106061453	200107201923	11/07/00	06/06/01	07/20/01	25.3	1.2	1.84E-06	1.84E-08	6.16E-08
194	100758	PS	PICO RIVERA W6	20001107	200106061305	bottle broken	11/07/00	06/06/01				1.47E-06	1.47E-08	7.59E-08
195	100759	PS	COMPTON 02	20001107	200106211458	200109171330	11/07/00	06/21/01	09/17/01	1.8	0.3	1.38E-06	1.38E-08	6.22E-08
196	100760	PS	COMPTON 01	20001107	200106211648	200111271537	11/07/00	06/21/01	11/27/01	0.3	0.2	1.33E-06	1.33E-08	6.15E-08
197	100761	PS	COMPTON 15	20001107	200107030520	200109171504	11/07/00	07/03/01	09/17/01	0.8	0.3	1.24E-06	1.24E-08	6.31E-08
198	100762	PS	LAKWOOD 17	20001106	200110242224	200108071753	11/06/00	10/24/01	08/07/01	18.9	0.9	2.61E-06	2.61E-08	6.95E-08
199	100763	PS	COMPTON 09	20001107	200106230032	200109251758	11/07/00	06/23/01	09/25/01	0.2	0.2	1.32E-06	1.32E-08	7.21E-08
200	100764	PS	LAKWOOD 22	20001106	200106230221	200108071922	11/06/00	06/23/01	08/07/01	-0.1	0.5	1.16E-06	1.16E-08	7.00E-08
201	100765	PS	HUNTINGTON PARK 16	20001108	200106230412	200108191420	11/08/00	06/23/01	08/19/01	1.7	0.5	1.40E-06	1.40E-08	6.21E-08
202	100766	PS	LAKWOOD 18	20001106	200110180429	200110312100	11/06/00	10/18/01	10/31/01	26.2	1.1	2.71E-06	2.71E-08	8.03E-08
203	100767	PS	COMPTON 18	20001107	200106222243	200109251715	11/07/00	06/22/01	09/25/01	18.0	0.9	2.19E-06	2.19E-08	7.01E-08
204	100768	PS	ORANGE 20	20001106	200106221716	200108191208	11/06/00	06/22/01	08/19/01	19.8	1.2	2.40E-06	2.40E-08	9.59E-08
205	100769	PS	ORANGE 21	20001106	200107061539	200109171421	11/06/00	07/06/01	09/17/01	30.5	1.1	2.58E-06	2.58E-08	1.65E-07
206	100770	PS	ORANGE 22	20001106	200110171929	200108282155	11/06/00	10/17/01	08/28/01	11.5	1.0	1.64E-06	1.64E-08	2.47E-07
207	100771	PS	ORANGE 09	20001106	200106221905	200109252138	11/06/00	06/22/01	09/25/01	23.5	0.7	1.95E-06	1.95E-08	1.45E-07
208	100772	PS	SANTA ANA 29	20001107	200110182043	200110301703	11/07/00	10/18/01	10/30/01	3.7	0.4	1.50E-06	1.50E-08	7.35E-08
209	100773	PS	ORANGE 08	20001106	200106222054	200108301457	11/06/00	06/22/01	08/30/01	26.0	1.5	2.21E-06	2.21E-08	1.13E-07
210	100774	PS	SANTA ANA 16	20001107	200105081739	200110301747	11/07/00	05/08/01	10/30/01	11.5	0.6	1.51E-06	1.51E-08	3.92E-07
211	100775	PS	SANTA ANA 28	20001108	200105082255	200110302043	11/08/00	05/08/01	10/30/01	8.8	0.5	1.60E-06	1.60E-08	1.02E-07
212	100776	PS	ORANGE 19	20001108	200110182232	200109252054	11/08/00	10/18/01	09/25/01	17.2	0.8	1.78E-06	1.78E-08	1.15E-07
213	100777	PS	ORANGE 18	20001108	200105081925	200110302126	11/08/00	05/08/01	10/30/01	14.2	1.0	1.99E-06	1.99E-08	1.07E-07
214	100778	PS	ORANGE 15	20001108	200105090602	200110301620	11/08/00	05/09/01	10/30/01	18.4	0.9	1.53E-06	1.53E-08	8.16E-08
215	100779	PS	SANTA ANA 35	20001107	200106221526	200108071415	11/07/00	06/22/01	08/07/01	3.0	0.6	1.54E-06	1.54E-08	6.65E-08
216	100780	PS	SANTA ANA 21	20001107	200107022352	200108071249	11/07/00	07/02/01	08/07/01	1.2	0.5	1.44E-06	1.44E-08	6.85E-08
217	100781	PS	FOUNTAIN VALLEY 03	20001107	200107022201	200108071459	11/07/00	07/02/01	08/07/01	-0.2	0.5	1.38E-06	1.38E-08	6.21E-08
218	100782	PS	SANTA ANA 27	20001107	200107022011	200108020035	11/07/00	07/02/01	08/02/01	10.4	1.1	1.58E-06	1.58E-08	1.20E-07
219	100783	PS	SANTA ANA 24	20001107	200107280627	200108191124	11/07/00	07/28/01	08/19/01	23.4	1.3	2.06E-06	2.06E-08	1.36E-07
220	100784	PS	TUSTIN VAND											

	A	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.																
7																	
8		+/-	Ne	+/-	Ar	+/-	Kr	+/-	Xe	+/-							
9	LLNL ID #	(cm³STP/g)	USGS ID #	State ID #	T(C) est	update	Altitude	pressure									
183	100747	1.59E-09	3.18E-07	6.36E-09	4.24E-04	8.47E-06	8.36E-08	2.51E-09	1.08E-08	3.25E-10	335612118070101	03S/12W-03J01 S	18.7	18.7	30	0.996	4.49E-08
184	100748	1.34E-09	2.75E-07	5.51E-09	4.01E-04	8.02E-06	8.16E-08	2.45E-09	1.08E-08	3.24E-10	335821118070801	02S/12W-27A05 S	17.7	17.7	30	0.996	4.51E-08
185	100749	1.36E-09	2.40E-07	4.81E-09	3.74E-04	7.47E-06	8.28E-08	2.48E-09	1.14E-08	3.43E-10	335226118125801	03S/13W-26M01 S	15.0	15.0	30	0.996	4.55E-08
186	100750	1.71E-09	3.46E-07	6.91E-09	4.22E-04	8.44E-06	8.64E-08	2.59E-09	1.10E-08	3.30E-10	335745118081701	02S/12W-28Q01 S	18.8	18.8	30	0.996	4.49E-08
187	100751	2.26E-09	4.60E-07	9.20E-09	4.76E-04	9.52E-06	9.31E-08	2.79E-09	1.22E-08	3.67E-10	335736118064501	02S/12W-35D02 S	17.4	17.4	30	0.996	4.51E-08
188	100752	1.81E-09	3.66E-07	7.31E-09	4.35E-04	8.70E-06	2.82E-07	8.45E-09			335817118070701	02S/12W-27H01 S	17.0	17.0	30	0.996	4.52E-08
189	100753	1.11E-09	2.46E-07	4.93E-09	3.57E-04	7.14E-06	7.95E-08	2.39E-09	1.05E-08	3.16E-10	340047118054601	02S/12W-12E08 S	17.9	17.9	30	0.996	4.51E-08
190	100754	1.42E-09	3.26E-07	6.52E-09	4.02E-04	8.04E-06	3.53E-07	1.06E-08	8.36E-09	2.51E-10	340044118051301	02S/12W-12E07 S	17.0	17.0	30	0.996	4.52E-08
191	100755	1.78E-09	3.99E-07	7.97E-09	4.43E-04	8.86E-06	8.90E-08	2.67E-09	1.07E-08	3.21E-10	335914118062501	02S/12W-23B04 S	21.2	21.2	30	0.996	4.46E-08
192	100756	1.61E-09	3.45E-07	6.91E-09	4.20E-04	8.41E-06	8.19E-08	2.46E-09	1.08E-08	3.25E-10	335826118164601	02S/12W-26D07 S	19.3	19.3	30	0.996	4.48E-08
193	100757	1.23E-09	2.70E-07	5.40E-09	3.76E-04	7.51E-06	7.92E-08	2.37E-09	1.01E-08	3.04E-10	340112118033701	02S/11W-05N04 S	20.0	20.0	30	0.996	4.48E-08
194	100758	1.52E-09	3.34E-07	6.69E-09	4.12E-04	8.25E-06	8.34E-08	2.50E-09	1.06E-08	3.18E-10	335806118164801	02S/12W-26E03 S	19.9	19.9	30	0.996	4.48E-08
195	100759	1.24E-09	2.55E-07	5.11E-09	3.88E-04	7.75E-06	8.39E-08	2.52E-09	1.19E-08	3.56E-10	335411118132001	03S/13W-15R01 S	14.0	14.0	30	0.996	4.57E-08
196	100760	1.23E-09	2.57E-07	5.14E-09	3.88E-04	7.77E-06	8.45E-08	2.54E-09	1.17E-08	3.51E-10	335350118132001	03S/13W-22H02 S	14.5	14.5	30	0.996	4.56E-08
197	100761	1.26E-09	2.47E-07	4.93E-09	3.81E-04	7.62E-06	8.08E-08	2.42E-09	1.07E-08	3.20E-10	335302118072201	03S/14W-27G01 S	17.5	17.5	30	0.996	4.51E-08
198	100762	1.39E-09	2.85E-07	5.70E-09	4.10E-04	8.20E-06	8.73E-08	2.62E-09	1.14E-08	3.41E-10	335123118071201	04S/12W-03H01 S	16.1	16.1	30	0.996	4.53E-08
199	100763	1.44E-09	2.89E-07	5.79E-09	4.18E-04	8.37E-06	9.40E-08	2.82E-09	1.20E-08	3.61E-10	335318118134401	03S/13W-22Q04 S	14.2	14.2	30	0.996	4.57E-08
200	100764	1.40E-09	2.42E-07	4.84E-09	3.87E-04	7.74E-06	8.56E-08	2.57E-09	1.14E-08	3.42E-10	335113118090801	04S/12W-05J01 S	15.1	15.1	30	0.996	4.55E-08
201	100765	1.24E-09	2.42E-07	4.85E-09	3.81E-04	7.62E-06	8.72E-08	2.62E-09	1.17E-08	3.51E-10	335822822125301	02S/13W-25D04 S	14.2	14.2	30	0.996	4.57E-08
202	100766	1.61E-09	3.69E-07	7.38E-09	4.33E-04	8.66E-06	2.35E-07	7.06E-09	1.25E-08	3.76E-10	335208118073801	03S/12W-34F01 S	14.5	14.5	30	0.996	4.56E-08
203	100767	1.40E-09	2.85E-07	5.69E-09	4.08E-04	8.17E-06	8.58E-08	2.57E-09	1.14E-08	3.42E-10	335433448125701	03S/13W-14F15 S	16.0	16.0	30	0.996	4.54E-08
204	100768	1.92E-09	3.92E-07	7.85E-09	4.65E-04	9.31E-06	9.26E-08	2.78E-09	1.22E-08	3.65E-10	334716117525301	04S/10W-36C02 S	16.1	16.1	30	0.996	4.54E-08
205	100769	3.30E-09	6.16E-07	1.23E-08	5.75E-04	1.15E-05	1.25E-07	3.75E-09	1.05E-08	3.16E-10	334911117510601	04S/09W-17N01 S	17.0	17.0	30	0.996	4.52E-08
206	100770	4.94E-09	1.01E-06	2.03E-08	5.09E-04	1.02E-05	3.76E-07	1.13E-08	1.18E-08	3.54E-10	334809117504001	04S/09W-20P01 S	17.0	17.0	30	0.996	4.52E-08
207	100771	2.90E-09	5.59E-07	1.12E-08	5.02E-04	1.00E-05	1.05E-07	3.14E-09	1.25E-08	3.75E-10	334826117521401	04S/10W-24J02 S	18.8	18.8	30	0.996	4.49E-08
208	100772	1.47E-09	3.18E-07	6.35E-09	3.96E-04	7.92E-06	8.47E-08	2.54E-09	1.17E-08	3.50E-10	334443117523401	05S/10W-13B09 S	16.0	16.0	30	0.996	4.54E-08
209	100773	2.26E-09	4.42E-07	8.84E-09	4.75E-04	9.51E-06	9.75E-08	2.93E-09	1.25E-08	3.76E-10	334822117521401	04S/10W-24J01 S	16.0	16.0	30	0.996	4.54E-08
210	100774	7.84E-09	1.54E-06	3.08E-08	6.64E-04	1.33E-05	1.32E-07	3.97E-09	1.49E-08	4.48E-10	334501117524001	05S/10W-12L03 S	17.0	17.0	30	0.996	4.52E-08
211	100775	2.04E-09	4.14E-07	8.27E-09	4.64E-04	9.28E-06	1.03E-07	3.09E-09	1.16E-08	3.49E-10	334635117512401	04S/09W-31R01 S	18.3	18.3	30	0.996	4.50E-08
212	100776	2.29E-09	4.55E-07	9.11E-09	4.63E-04	9											

	A	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.																	
7		excess		excess		Xe equil												
8		Ne	Ne xs	Xe	+-	(alt = 0)	+-	T(C)		Meas	Mean nonrad			⁴ He rad	+-	⁴ He rad	+-	rad cor
9	LLNL ID#	Ne equil	(cm ³ STP/g)	as air	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	calculation	+-	⁴ He/Ne	⁴ He/Ne	+-	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	(cm ³ STP/g)	³ He/ ⁴ He
183	100747	1.87E-07	1.31E-07	0.0072	9.43E-10	3.14E-10	9.91E-09	4.52E-10	18.7	1.5	0.251	0.250	0.014	1.40E-10	4.61E-09	1.40E-10	4.61E-09	2.23E-06
184	100748	1.88E-07	8.70E-08	0.0048	6.24E-10	2.08E-10	1.02E-08	3.85E-10	17.7	1.2	0.243	0.247	0.011	-1.01E-09	3.24E-09	0.00E+00	3.24E-09	2.22E-06
185	100749	1.93E-07	4.75E-08	0.0026	3.41E-10	1.14E-10	1.11E-08	3.61E-10	15.0	1.0	0.283	0.241	0.007	1.01E-08	2.08E-09	1.01E-08	2.08E-09	1.30E-06
186	100750	1.87E-07	1.59E-07	0.0087	1.14E-09	3.80E-10	9.88E-09	5.03E-10	18.8	1.7	0.248	0.251	0.015	-1.32E-09	5.50E-09	0.00E+00	5.50E-09	1.54E-06
187	100751	1.89E-07	2.71E-07	0.0149	1.94E-09	6.48E-10	1.03E-08	7.45E-10	17.4	2.3	0.245	0.253	0.020	-3.61E-09	9.51E-09	0.00E+00	9.51E-09	1.63E-06
188	100752	1.90E-07	1.76E-07	0.0097	1.26E-09	4.21E-10	-1.27E-09	4.21E-10	no Xe	no Xe	0.248	0.250	0.017	-7.31E-10	6.32E-09	0.00E+00	6.32E-09	1.60E-06
189	100753	1.88E-07	5.84E-08	0.0032	4.20E-10	1.40E-10	1.01E-08	3.46E-10	17.9	1.1	0.226	0.245	0.008	-4.74E-09	2.31E-09	0.00E+00	2.31E-09	1.96E-06
190	100754	1.90E-07	1.36E-07	0.0075	9.79E-10	3.26E-10	7.41E-09	4.11E-10	28.6	1.9	0.218	0.249	0.014	-1.01E-08	4.96E-09	0.00E+00	4.96E-09	1.93E-06
191	100755	1.83E-07	2.16E-07	0.0119	1.55E-09	5.16E-10	9.20E-09	6.08E-10	21.2	2.2	0.224	0.255	0.017	-1.25E-08	6.98E-09	0.00E+00	6.98E-09	1.58E-06
192	100756	1.86E-07	1.59E-07	0.0088	1.14E-09	3.81E-10	9.73E-09	5.01E-10	19.3	1.7	0.233	0.252	0.015	-6.63E-09	5.46E-09	0.00E+00	5.46E-09	1.51E-06
193	100757	1.85E-07	8.49E-08	0.0047	6.10E-10	2.03E-10	9.54E-09	3.65E-10	20.0	1.3	0.228	0.249	0.010	-5.62E-09	3.03E-09	0.00E+00	3.03E-09	1.84E-06
194	100758	1.85E-07	1.49E-07	0.0082	1.07E-09	3.57E-10	9.58E-09	4.79E-10	19.9	1.7	0.227	0.252	0.014	-8.32E-09	5.07E-09	0.00E+00	5.07E-09	1.47E-06
195	100759	1.95E-07	6.09E-08	0.0033	4.37E-10	1.46E-10	1.15E-08	3.85E-10	14.0	1.0	0.244	0.241	0.009	6.40E-10	2.56E-09	6.40E-10	2.56E-09	1.39E-06
196	100760	1.94E-07	6.34E-08	0.0035	4.55E-10	1.52E-10	1.13E-08	3.83E-10	14.5	1.1	0.239	0.242	0.009	-6.46E-10	2.63E-09	0.00E+00	2.63E-09	1.33E-06
197	100761	1.89E-07	5.78E-08	0.0032	4.15E-10	1.38E-10	1.03E-08	3.49E-10	17.5	1.1	0.256	0.245	0.008	2.81E-09	2.30E-09	2.81E-09	2.30E-09	1.29E-06
198	100762	1.91E-07	9.40E-08	0.0052	6.75E-10	2.25E-10	1.07E-08	4.09E-10	16.1	1.2	0.244	0.246	0.012	-4.90E-10	3.59E-09	0.00E+00	3.59E-09	2.61E-06
199	100763	1.94E-07	9.52E-08	0.0052	6.83E-10	2.28E-10	1.14E-08	4.27E-10	14.2	1.2	0.249	0.244	0.012	1.57E-09	3.77E-09	1.57E-09	3.77E-09	1.35E-06
200	100764	1.93E-07	4.91E-08	0.0027	3.53E-10	1.18E-10	1.11E-08	3.62E-10	15.1	1.0	0.289	0.241	0.007	1.16E-08	2.13E-09	1.16E-08	2.13E-09	1.36E-06
201	100765	1.94E-07	4.81E-08	0.0026	3.45E-10	1.15E-10	1.14E-08	3.70E-10	14.2	1.0	0.256	0.240	0.007	3.91E-09	2.12E-09	3.91E-09	2.12E-09	1.48E-06
202	100766	1.94E-07	1.75E-07	0.0097	1.26E-09	4.20E-10	1.13E-08	5.63E-10	14.5	1.5	0.218	0.248	0.017	-1.11E-08	6.67E-09	0.00E+00	6.67E-09	2.71E-06
203	100767	1.91E-07	9.34E-08	0.0051	6.70E-10	2.23E-10	1.08E-08	4.09E-10	16.0	1.2	0.247	0.245	0.012	2.99E-10	3.57E-09	2.99E-10	3.57E-09	2.20E-06
204	100768	1.91E-07	2.01E-07	0.0111	1.45E-09	4.82E-10	1.07E-08	6.04E-10	16.1	1.8	0.244	0.250	0.018	-2.23E-09	7.34E-09	0.00E+00	7.34E-09	2.40E-06
205	100769	1.90E-07	4.26E-07	0.0234	3.06E-09	1.02E-09	7.49E-09	1.07E-09	28.2	4.9	0.268	0.255	0.024	7.68E-09	1.50E-08	7.68E-09	1.50E-08	2.69E-06
206	100770	1.90E-07	8.23E-07	0.0453	5.91E-09	1.97E-09	5.90E-09	2.00E-09	36.2	11.1	0.244	0.258	0.028	-1.48E-08	2.88E-08	0.00E+00	2.88E-08	1.64E-06
207	100771	1.87E-07	3.73E-07	0.0205	2.67E-09	8.92E-10	9.88E-09	9.67E-10	18.8	3.2	0.260	0.256	0.022	1.94E-09	1.26E-08	1.94E-09	1.26E-08	1.98E-06
208	100772	1.91E-07	1.26E-07	0.0070	9.08E-10	3.03E-10	1.08E-08	4.63E-10	16.0	1.4	0.231	0.247	0.014	-5.00E-09	4.73E-09	0.00E+00	4.73E-09	1.50E-06
209	100773	1.91E-07	2.51E-07	0.0138	1.80E-09	6.00E-10	1.08E-08	7.08E-10	16.0	2.1	0.255	0.251	0.020	1.70E-09	9.11E-09	1.70E-09	9.11E-09	2.24E-06
210	100774	1.90E-07	1.35E-06	0.0742	9.69E-09	3.23E-09	5.27E-09	3.26E-09	39.8	19.5	0.255	0.260	0.030	-7.96E-09	4.71E-08	0.00E+00	4.71E-08	1.51E-06
211	100775	1.88E-07	2.26E-07	0.0124	1.62E-09	5.41E-10	1.0											

	A	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.														
7		Excess air								Assume no rad ${}^4\text{He}$					
8		${}^4\text{He}$	Air derived	${}^3\text{He}$ from ${}^3\text{H}$	(cm 3 STP/g)	+	Age	+	${}^3\text{He}$ from ${}^3\text{H}$	+	Age	+	vintage	initial ${}^3\text{H}$	estimate
9	LLNL ID#	+	(cm 3 STP/g)	3He/4He	(cm 3 STP/g)	(cm 3 STP/g)	(yr)	(yr)	(pCi/L)	(pCi/L)	(yr)	(yr)		% premod	
183	100747	1.19E-07	3.77E-08	1.37E-06	6.71E-14	9.50E-15	21	2	6.70E-14	1.77E-15	21	1	12/08/79	120.3	-4%
184	100748	1.00E-07	2.50E-08	1.37E-06	5.63E-14	6.71E-15	21	2	5.63E-14	1.49E-15	21	1	10/26/79	100.6	15%
185	100749	5.02E-08	1.36E-08	1.37E-06	-3.96E-15	2.91E-15	>50	0	-1.57E-14	7.73E-16	>50	0	na	na	100%
186	100750	8.73E-08	4.56E-08	1.37E-06	1.30E-14	7.47E-15	10	5	1.30E-14	1.31E-15	10	1	02/24/91	35.4	12%
187	100751	1.22E-07	7.78E-08	1.38E-06	2.80E-14	1.37E-14	20	6	2.80E-14	1.84E-15	20	1	04/05/81	51.5	48%
188	100752	9.91E-08	5.05E-08	1.37E-06	2.08E-14	8.99E-15	>50	0	2.08E-14	1.46E-15	>50	0	na	na	100%
189	100753	7.57E-08	1.68E-08	1.37E-06	3.25E-14	4.21E-15	17	2	3.25E-14	1.09E-15	17	1	01/04/84	65.1	10%
190	100754	1.22E-07	3.91E-08	1.37E-06	3.83E-14	8.68E-15	20	3	3.83E-14	1.37E-15	20	1	02/22/81	68.3	32%
191	100755	1.09E-07	6.19E-08	1.38E-06	1.72E-14	9.74E-15	11	5	1.72E-14	1.41E-15	11	1	02/25/90	44.5	-4%
192	100756	9.02E-08	4.58E-08	1.38E-06	1.01E-14	7.24E-15	7	5	1.01E-14	1.21E-15	7	1	06/19/93	35.1	1%
193	100757	8.27E-08	2.44E-08	1.37E-06	2.82E-14	5.09E-15	15	2	2.82E-14	1.13E-15	15	1	07/12/85	59.8	4%
194	100758	8.63E-08	4.29E-08	1.37E-06	7.45E-15	6.55E-15	>50	0	7.45E-15	1.12E-15	>50	0	na	na	100%
195	100759	5.10E-08	1.75E-08	1.37E-06	1.27E-15	3.14E-15	>50	0	5.21E-16	8.58E-16	>50	0	na	na	100%
196	100760	4.99E-08	1.82E-08	1.37E-06	-2.57E-15	3.07E-15	>50	0	-2.57E-15	8.17E-16	>50	0	na	na	100%
197	100761	4.30E-08	1.66E-08	1.37E-06	-4.58E-15	2.59E-15	>50	0	-7.87E-15	7.86E-16	>50	0	na	na	100%
198	100762	1.27E-07	2.70E-08	1.37E-06	8.52E-14	8.83E-15	33	2	8.52E-14	1.81E-15	33	1	08/23/67	122.3	82%
199	100763	6.17E-08	2.73E-08	1.37E-06	-1.66E-15	4.35E-15	>50	0	-3.49E-15	9.54E-16	>50	0	na	na	100%
200	100764	5.50E-08	1.41E-08	1.37E-06	-6.19E-16	3.21E-15	>50	0	-1.42E-14	8.15E-16	>50	0	na	na	100%
201	100765	4.80E-08	1.38E-08	1.37E-06	6.36E-15	2.79E-15	>50	0	1.80E-15	8.68E-16	>50	0	na	na	100%
202	100766	2.10E-07	5.04E-08	1.38E-06	1.06E-13	1.69E-14	32	2	1.06E-13	2.17E-15	32	1	03/23/69	154.5	71%
203	100767	1.04E-07	2.68E-08	1.37E-06	5.74E-14	7.28E-15	29	2	5.71E-14	1.54E-15	28	1	05/07/72	89.0	73%
204	100768	1.70E-07	5.78E-08	1.38E-06	9.77E-14	1.63E-14	35	3	9.77E-14	2.30E-15	35	1	11/20/65	141.1	84%
205	100769	2.29E-07	1.22E-07	1.38E-06	2.06E-13	3.59E-14	40	3	1.97E-13	4.25E-15	39	1	12/27/60	285.9	85%
206	100770	1.68E-07	2.36E-07	1.38E-06	6.18E-14	4.15E-14	36	11	6.18E-14	4.04E-15	36	2	12/10/64	86.6	92%
207	100771	1.55E-07	1.07E-07	1.38E-06	8.49E-14	2.22E-14	30	4	8.26E-14	2.83E-15	30	1	07/24/70	128.6	70%
208	100772	8.48E-08	3.63E-08	1.37E-06	8.98E-15	6.24E-15	24	10	8.98E-15	1.10E-15	24	2	07/05/76	14.5	92%
209	100773	1.66E-07	7.21E-08	1.38E-06	9.53E-14	1.85E-14	30	3	9.33E-14	2.49E-15	30	1	05/15/70	144.1	68%
210	100774	1.58E-07	3.88E-07	1.38E-06	4.80E-14	6.18E-14	33	19	4.80E-14	5.91E-15	33	2	05/03/68	71.5	88%
211	100775	1.08E-07	6.49E-08	1.38E-06	2.22E-14	1.10E-14	25	7	2.22E-14	1.63E-15	25	1	06/23/75	36.5	83%
212	100776	1.28E-07	7.70E-08	1.38E-06	4.55E-14	1.47E-14	26	4	4.55E-14	2.04E-15	26	1	05/03/75	72.1	66%
213	100777	1.50E-07	7.31E-08	1.38E-06	6.50E-14	1.61E-14	34	4	6.50E-14	2.13E-15	34	1	12/02/66	95.5	87%
214	100778	8.63E-08	4.13E-08	1.37E-06	1.22E-14	7.04E-15	11	5	1.22E-14	1.25E-15	11	1	04/30/90	33.1	22%
215	100779	6.96E-08	2.53E-08	1.37E-06	1.10E-14	4.63E-15	30	7	1.10E-14	1.02E-15	30	3	08/06/70	16.6	96%
216	100780	7.35E-08	3.09E-08	1.37E-06	4.74E-15	5.04E-15	>50	0	4.74E-15	9.88E-16	>50	0	na	na	100%
217	100781	5.39E-08	2.06E-08	1.37E-06	3.51E-16	3.34E-15	>50	0	3.51E-16	8.54E-16	>50	0	na	na	100%
218	100782	1.13E-07	8.48E-08	1.38E-06	2.37E-14	1.36E-14	24	8	2.37E-14	1.90E-15	24	2	02/09/77	39.6	76%
219	100783	1.79E-07	1.08E-07	1.38E-06	9.18E-14	2.43E-14	31	4	9.18E-14	2.80E-15	31	1	06/09/69	136.4	73%
220	100784	2.49E-07	1.39E-07	1.37E-06	3.54E-13	4.31E-14	87	3	1.59E-13	6.25E-15	73	1	08/18/13	448.2	100%
221	100785	6.68E-08	1.38E-08	1.37E-06	3.92E-14	3.86E-1									

	A	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV
6	Table B-1. Analytical and calculated results for the full suite of dissolved noble gas and tritium analyses, including analytical and propagated errors.													
7														
8														
9	LLNL ID#	Ar equil	Kr equil	Ar pxs	Kr pxs	Ar p	+-	Kr p	+-	normdev Ar	normdev Kr	chisqr	temp	+-
183	100747	3.18E-04	7.17E-08	7.49E-05	1.03E-08	3.93E-04	8.24E-06	8.20E-08	2.57E-09	2.55	0.46	6.7	18.7	1.5
184	100748	3.25E-04	7.35E-08	4.96E-05	6.82E-09	3.75E-04	5.46E-06	8.03E-08	1.70E-09	2.72	0.45	7.6	17.7	1.2
185	100749	3.44E-04	7.89E-08	2.71E-05	3.72E-09	3.71E-04	2.98E-06	8.26E-08	9.30E-10	0.36	0.07	0.1	15.0	1.0
186	100750	3.18E-04	7.15E-08	9.06E-05	1.25E-08	4.08E-04	9.97E-06	8.39E-08	3.11E-09	1.05	0.60	1.5	18.8	1.7
187	100751	3.27E-04	7.41E-08	1.54E-04	2.12E-08	4.82E-04	1.70E-05	9.53E-08	5.31E-09	-0.28	-0.38	0.2	17.4	2.3
188	100752	3.30E-04	7.49E-08	1.00E-04	1.38E-08	4.30E-04	1.10E-05	8.87E-08	3.45E-09	0.36	21.15	no Xe	no Xe	na
189	100753	3.23E-04	7.31E-08	3.33E-05	4.58E-09	3.57E-04	3.67E-06	7.77E-08	1.15E-09	0.04	0.70	0.5	17.9	1.1
190	100754	3.30E-04	7.49E-08	7.77E-05	1.07E-08	4.07E-04	8.55E-06	8.55E-08	2.67E-09	-0.48	24.48	599.5	bad fit	na
191	100755	3.03E-04	6.74E-08	1.23E-04	1.69E-08	4.26E-04	1.35E-05	8.43E-08	4.22E-09	1.03	0.94	1.9	21.2	2.2
192	100756	3.15E-04	7.06E-08	9.09E-05	1.25E-08	4.06E-04	1.00E-05	8.31E-08	3.12E-09	1.13	-0.30	1.4	19.3	1.7
193	100757	3.11E-04	6.95E-08	4.84E-05	6.66E-09	3.59E-04	5.33E-06	7.61E-08	1.66E-09	1.79	1.04	4.3	20.0	1.3
194	100758	3.11E-04	6.97E-08	8.51E-05	1.17E-08	3.96E-04	9.37E-06	8.14E-08	2.93E-09	1.28	0.53	1.9	19.9	1.7
195	100759	3.51E-04	8.09E-08	3.47E-05	4.77E-09	3.86E-04	3.82E-06	8.57E-08	1.19E-09	0.25	-0.64	0.5	14.0	1.0
196	100760	3.47E-04	7.99E-08	3.61E-05	4.97E-09	3.83E-04	3.98E-06	8.49E-08	1.24E-09	0.56	-0.12	0.3	14.5	1.1
197	100761	3.27E-04	7.40E-08	3.29E-05	4.53E-09	3.59E-04	3.62E-06	7.85E-08	1.13E-09	2.57	0.88	7.4	17.5	1.1
198	100762	3.36E-04	7.66E-08	5.36E-05	7.37E-09	3.89E-04	5.90E-06	8.39E-08	1.84E-09	2.07	1.05	5.4	16.1	1.2
199	100763	3.50E-04	8.05E-08	5.43E-05	7.46E-09	4.04E-04	5.97E-06	8.80E-08	1.87E-09	1.42	1.78	5.2	14.2	1.2
200	100764	3.43E-04	7.87E-08	2.80E-05	3.85E-09	3.71E-04	3.08E-06	8.25E-08	9.62E-10	1.88	1.13	4.8	15.1	1.0
201	100765	3.50E-04	8.05E-08	2.74E-05	3.77E-09	3.77E-04	3.02E-06	8.43E-08	9.42E-10	0.49	1.05	1.3	14.2	1.0
202	100766	3.47E-04	7.99E-08	1.00E-04	1.38E-08	4.47E-04	1.10E-05	9.37E-08	3.44E-09	-1.02	18.04	326.4	bad fit	na
203	100767	3.37E-04	7.68E-08	5.32E-05	7.32E-09	3.90E-04	5.86E-06	8.42E-08	1.83E-09	1.83	0.51	3.6	16.0	1.2
204	100768	3.36E-04	7.66E-08	1.15E-04	1.58E-08	4.51E-04	1.26E-05	9.24E-08	3.95E-09	0.94	0.04	0.9	16.1	1.8
205	100769	3.30E-04	7.49E-08	2.43E-04	3.34E-08	5.73E-04	2.67E-05	1.08E-07	8.35E-09	0.06	1.81	3.3	17.0	4.9
206	100770	3.30E-04	7.49E-08	4.70E-04	6.45E-08	7.99E-04	5.17E-05	1.39E-07	1.61E-08	-5.52	12.03	175.2	bad fit	na
207	100771	3.18E-04	7.15E-08	2.12E-04	2.92E-08	5.30E-04	2.34E-05	1.01E-07	7.30E-09	-1.13	0.51	1.5	18.8	3.2
208	100772	3.37E-04	7.69E-08	7.21E-05	9.91E-09	4.09E-04	7.93E-06	8.68E-08	2.48E-09	-1.15	-0.61	1.7	16.0	1.4
209	100773	3.36E-04	7.68E-08	1.43E-04	1.97E-08	4.79E-04	1.57E-05	9.64E-08	4.92E-09	-0.23	0.20	0.1	16.0	2.1
210	100774	3.30E-04	7.49E-08	7.70E-04	1.06E-07	1.10E-03	8.47E-05	1.81E-07	2.64E-08	-5.08	-1.81	29.1	bad fit	na
211	100775	3.21E-04	7.25E-08	1.29E-04	1.77E-08	4.50E-04	1.42E-05	9.02E-08	4.43E-09	0.81	2.37	6.3	18.3	2.1
212	100776	3.21E-04	7.23E-08	1.53E-04	2.10E-08	4.74E-04	1.68E-05	9.33E-08	5.25E-09	-0.56	0.64	0.7	18.4	2.4
213	100777	3.26E-04	7.39E-08	1.45E-04	2.00E-08	4.72E-04	1.60E-05	9.39E-08	4.99E-09	0.51	0.13	0.3	17.5	2.2
214	100778	3.30E-04	7.49E-08	8.20E-05	1.13E-08	4.12E-04	9.02E-06	8.62E-08	2.82E-09	0.71	-0.05	0.5	17.0	1.5
215	100779	3.36E-04	7.65E-08	5.02E-05	6.90E-09	3.86E-04	5.52E-06	8.34E-08	1.72E-09	1.83	0.21	3.4	16.2	1.2
216	100780	3.29E-04	7.48E-08	6.14E-05	8.43E-09	3.91E-04	6.75E-06	8.32E-08	2.11E-09	1.70	-0.16	2.9	17.1	1.3
217	100781	3.26E-04	7.39E-08	4.09E-05	5.62E-09	3.67E-04	4.50E-06	7.95E-08	1.40E-09	2.02	-0.46	4.3	17.5	1.2
218	100782	3.11E-04	6.96E-08	1.68E-04	2.31E-08	4.79E-04	1.85E-05	9.28E-08	5.79E-09	0.90	-0.11	0.8	19.9	2.7
219	100783	3.23E-04	7.30E-08	2.15E-04	2.96E-08	5.39E-04	2.37E-05	1.03E-07	7.40E-09	2.11	-0.09	4.5	18.0	3.2
220	100784	3.11E-04	6.96E-08	2.77E-04	3.80E-08	5.88E-04	3.04E-05	1.08E-07	9.50E-09	0.32	0.11	0.1	19.9	4.3
221	100785	3.29E-04	7.46E-08	2.73E-05	3.76E-09	3.56E-04	3.01E-06	7.84E-08	9.40E-10	1.93	-0.73	4.3	17.1	1.1
222	100786	3.02												